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Editor:

FREDERICK HOBDAY, C.M.G., F.R.C.V.S., F.R.S.E.,
HONORARY VETERINARY SURGEON TO HIS MAJESTY THE KING,
OFFICIER DU MÉRITE AGRICOLE (FRANCE),
CAVALIERE DEI SS. MAURIZIO E LAZZARO (ITALY),
HONORARY MEMBER OF THE AMERICAN VETERINARY ASSOCIATION,
PRINCIPAL OF THE ROYAL VETERINARY COLLEGE, LONDON.

Sub-Editor:

GLADSTONE MAYALL, M.R.C.V.S.

APRIL, 1932.

VETERINARY RESEARCH AND SHEEP DISEASES.

OUR readers cannot fail to be pleased with the splendid response which has been made to the Editorial appeal for articles from research workers who have made special studies on the diseases of sheep; and it is very gratifying to note not only the amount of attention which is being paid at the present time to this branch of farming stock, but also the excellent results which have been attained in a comparatively short period of years. For want of space we have been compelled to hold over a number of important articles until the next issue.

Only so recently as a decade ago it was estimated that the unrecorded annual losses of sheep and lambs in this country amounted to tens of thousands, and the average farmer looked upon a certain percentage of deaths each season as a matter of course, especially at lambing time.

The research work of Gaiger, Dalling, Russell Greig, Montgomerie, and Lyle Stewart, to mention only a few of the laboratory workers, and the able collaboration of the general practitioners and large sheep breeders in the districts where sheep are to be found in large flocks, has resulted in a saving to the country and to agriculturists of hundreds of thousands of pounds.

It is a further argument for the necessity of supporting the scheme which has at last taken practical shape, and which the veterinary profession have for years been urgently asking for—for properly organised research into the diseases of the farm animals. It is for the newly formed Veterinary Research Council to see that this work is carried on in the future. Starved as it has been in this direction in the past, the profession has at last commenced to come into its own; and the success which has been attained in this direction in so short a period with the diseases of sheep is a proof that if the Government will only provide the opportunity and proper equipment, the profession in this country can supply scientists who can do the work as satisfactorily as it is done in other countries whose respective Governments have long ago given the Veterinary Surgeon his legitimate position as the proper person to conduct the fight against the diseases of animals.

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General Articles

A CONSIDERATION OF THE DIFFICULTIES IN CONNECTION WITH THE ERADICATION OF SHEEP SCAB IN GREAT BRITAIN.

By R. SIMPSON, F.R.C.V.S., D.V.S.M.
Chief Veterinary Officer, Cumberland.

THE control of sheep scab in Great Britain involves local authorities annually in a considerable amount of administrative effort and expenditure, and it is disappointing that the sustained efforts which have been made for a good many years now have not been successful in bringing about the eradication of this disease. The latest published figures of the Ministry of Agriculture relative to outbreaks of sheep scab show that in 1930 there was a reduction of 28 per cent. in the number of outbreaks as compared to 1929, and the figures for the latter year again show a reduction of 10 per cent. in 1928. These figures are somewhat encouraging, but should be capable of substantial improvement.

According to the official reports, Wales, in 1930, provided 46 per cent. of the total of 478 outbreaks confirmed in Great Britain. Scotland, on the other hand, has shown a progressive improvement for the last five years, and this improvement is reflected in the diminution of the number of outbreaks found in this county attributable to imported sheep from Scotland. Approximately a quarter of a million sheep are imported into Cumberland from Scotland every year, and whereas in the years 1921–1924 79 per cent. of the Cumberland outbreaks were due to imported Scotch sheep, in 1928–1931 the percentage of outbreaks in the county attributable to these sheep has dropped to *nil*. The problem presented in connection with the eradication of this disease closely concerns the veterinary profession, and especially those members of the profession who are engaged in the administration of the Diseases of Animals Acts and Orders.

So far as diagnosis is concerned in this disease, little difficulty is experienced in dealing with cases where the disease is well established. The detection of the parasites in active lesions is easily carried out by an examination of the material from the lesions, either by a hand lens, or with the aid of the low power of the microscope. It is important to bear in mind in this connection, that accuracy of diagnosis and the retention of specimens are necessary, in view of the owners' right of appeal under the Sheep Scab Order of 1928. The detection of early cases, however, which have to be picked out, often in the course of gatherings of sheep for dippings on hill farms, and where the clinical evidence is small, calls for considerable experience and powers of observation, which only become developed in the individual by continued experience in dealing with the disease. In such cases, I prefer sheep being loosely gathered together, rather than being tightly

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penned up when any examination for the presence of scab has to be carried out amongst considerable numbers of sheep in hill districts. If the sheep have been driven previously to examination and thus heated, the detection of cases is often rendered easier.

From a purely theoretical standpoint there would appear to be no unsurmountable difficulties in the way of eradication of the disease in this country. The life-history of the parasite responsible has been carefully and accurately worked out, and the measures based on this knowledge, if applied universally and thoroughly, should lead to the extermination of the disease, and yet, after a considerable number of years, it cannot be said that a really definite approach is being made towards eradication.

After a prolonged period of experience in connection with the control of sheep scab, there seems to be no doubt, in my view, that lack of co-operation on the part of sheep owners has been one of the main factors hitherto in holding up definite progress towards eradication. Fortunately, there is some evidence of a change of mind amongst sheep farmers, possibly as the result of the penalties which have been imposed in cases of concealment and failure to report suspected cases of the disease. Nevertheless, the success of anti-scab measures will depend in the long run not so much on prosecutions and fines, but on the measure of willing co-operation which agriculturists are prepared to give. It must be conceded, however, that in certain districts the sheep farmer has very considerable difficulties to contend with. In Cumberland there are large fell districts which are completely open for many miles, and where sheep may roam without hindrance over large tracts of country. Similarly, there are hill districts common to more than one county, each having its own particular regulations or, it may be, none at all. Such conditions make a complete gathering of sheep a difficult procedure, and often results in sheep being left unexamined and undipped for prolonged periods. Stray sheep affected with scab in such districts may do much damage in spreading infection and perpetuating the disease. Such difficulties can only be overcome by co-operative effort on the part of the farmers in these hill districts, and it should be the endeavour of local authorities in such areas to stimulate such action in every way possible. The problem of stray sheep can only be solved in this way. Periodical collection of sheep for dipping, if carried out at prearranged dates and times, ensures that all sheep will come under the examination of the owners and, if necessary, by the veterinary inspectors of the local authorities concerned.

The elucidation of the life-history of the parasite shows that theoretically, at any rate, two dippings, with an interval of not less than eight days and not more than fourteen days between the two dippings, is sufficient to inhibit completely the further development of the parasite. On this basis the measures of control of the disease laid down by the Ministry of Agriculture have been formulated. The fact that two dippings are necessary for the control and prevention of the disease has been persistently instilled into the minds of sheep farmers for a good

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many years now, to such an extent possibly that there is now a danger that the purely theoretical point of view has excluded the essentially practical consideration that most clinical cases of scab require more than two dippings before a cure can be effected. In other words, double dipping has therefore to some extent created a false sense of security in the minds of sheep farmers, especially when it is carried out over large areas, and has thus possibly led to carelessness and even neglect on the part of sheep owners to keep up a close watch for the development of the disease. Concealment of the disease is undoubtedly far too common, and some of this is no doubt due to ill-placed consideration for the interests of neighbouring farmers whose stocks may be in contact. Modern methods of marketing, however, make the concealment of sheep scab less easy than formerly. The worst feature of these cases of concealment is that so much damage and inconvenience is caused to other persons who quite honestly and faithfully are endeavouring to keep their sheep free from disease.

Eradication of the disease is also considerably hampered by the large amount of inefficient dipping which constantly takes place in spite of the efforts of local authorities to exercise supervision as far as possible. Dipping is too often regarded as being something required merely for the purpose of enabling sheep farmers to complete certain forms, and hand them to their nearest police officer. Insufficient concentration of the dipping, neglect to replenish the contents of the bath from time to time as may be required, and insufficient exposure of the sheep to the dip, are faults which commonly come under notice in many parts of the country. There is a great tendency amongst sheep farmers to consider that increased strength of the dip renders it unnecessary that the sheep should be immersed for the prescribed period of one minute. In many places it is common to find poorly constructed dipping places, where the baths are not of sufficient capacity to provide for the number of sheep to be dipped, and where the catching pens are uncemented or otherwise not rendered impervious, with the consequence that much dirt is carried into the baths, leading to the strength of the dip being quickly reduced below the necessary strength to secure efficient dipping.

No consideration of the control of scab is complete without reference to the question of dips and their general standard of efficiency. There seems to be room for considerable inquiry and research into the whole question of the efficiency of dips, their effects on the scab parasite, and on the sheep. The number of approved dips seems unnecessarily large. Experience in the treatment of a very considerable number of clinical cases of sheep scab has convinced me that a considerable proportion of the dips approved have only a small margin of efficiency when used at the approved strength. Manufacturers of dips appear to be striving after the marketing of a dip which will not only be an effective anti-scab agent, but which will in summer protect the sheep against the attacks of " fly," and in winter act as a proofing agent for the sheep, and the result is quite often a dip which may conceivably effect one of the objects aimed at, but which more often than not has a low margin of efficiency for anti-scab purposes.

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In recent years, especially for winter use, dips with a high grease content have been popular amongst sheep farmers, and the higher the grease content, the more popular is the dip, and incidentally, the more expensive. Such dips are believed to proof the sheep, and enable them better to withstand climatic extremes of cold and wet. It is doubtful, however, if such dips have a reasonable margin of efficiency, owing to the fact that the grease in them prohibits the penetration of the tar acids on which their efficiency is based, and thus nullifies their effects on the scab acari. Further research work might well be devoted to this important aspect of the question with a view to limiting the present varied ingredients in dips, and probably leading up to a fixed official standard of dip which could be relied upon by farmers to give a wide margin of efficiency for scab, combined with general safety both to the user and the sheep. The present policy of attempting to secure several objectives at one and the same time may to some extent explain past failures to secure more rapid eradication of the disease.

The list of scheduled contagious animal diseases which have ceased to exist in this country within recent years is a gradually increasing one, which reflects a considerable amount of credit on the veterinary profession. One is optimistic enough to hope that in the not too distant future sheep scab may be added to that list. Its disappearance from this country would certainly mean a very large saving of time and money which is now spent in the control of the disease, and at the same time relieve agriculturists of a disagreeable burden.

SWINGBACK (ATAXIA) IN LAMBS.

By W. LYLE STEWART, M.R.C.V.S.

Agricultural Department, Armstrong College, Newcastle-upon-Tyne.

" SWINGBACK " is the shepherd's name for a chronic disease affecting the nervous system of young lambs, which is characterised by muscular inco-ordination of the hind limbs (ataxia). In all probability the disease occurs to a limited extent in most counties in Britain, but is observed chiefly in areas of the sheep-breeding districts of the South of Scotland and North of England. Occasionally " swingback " has appeared as a veritable plague affecting hundreds of lambs, but in the Border counties the disease is perhaps best known as an enzootic on certain farms, where it may cause a mortality fluctuating between 2 per cent. and 10 per cent. of total lambs born. It is believed that all breeds of sheep are susceptible to " swingback," but undoubtedly it is more prevalent in the mountain breeds, and particularly in the progeny of the blackfaced ewe and Leicester ram—the so-called " mule " or " greyface " lamb. The disease is also commonly observed in Blackface and Cheviot lambs.

The name " swingback " is derived from the predominant symptom of the disease, which is a helpless swinging or swaying of the lumbar region and hind quarters. Excitement of any kind aggravates the condition to a great extent, and affected lambs which are driven for half a mile or so frequently take the

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ground in an exhausted state, but partially recover if left alone, and are able to proceed. The disease, however, runs a certain and progressive course, and sooner or later affected animals become permanently unable to rise, and since they are useless are usually destroyed.

Ewes do not appear to act as carriers of the disease from year to year, since commonly they produce swingbacked lambs one year, and healthy lambs subsequently. According to the information available, it appears to be rare for ewes to give birth to swingbacked lambs two years in succession. An approximately equal number of twin and single lambs contract " swingback " ; that is to say, there is no evidence to show that the disease is more prone to occur in twins or single lambs, and it is possibly equally common in the progeny of ewes the first and second years after drafting from the higher hill farms. The following, however, is noticeable : one lamb of a pair may be noted affected with " swingback " shortly after birth, or a few days afterwards, and in the meantine the other lamb may appear perfectly healthy ; this lamb may develop normally for weeks, but sooner or later it invariably shows symptoms of ataxia, and succumbs to the disease. In a wide experience of " swingback," extending over twenty years, one observer has not known a single exception to this rule.

The cause of " swingback " is unknown. Among stockowners the favourite theory is that it arises from faulty conditions or deficiencies in the subsoil, but there is no general consensus of opinion as to what these deficiencies are. Other stockowners state that in their experience it has always occurred when hill sheep have been wintered on too rich but unvaried keep. Tsurrma, a Japanese investigator, considered that the disease was caused by larvæ of certain parasitic worms invading the cerebro-spinal fluid. Professor Gaiger investigated a paralytic disease of sheep in Peru, which in its clinical manifestations was indistinguishable from " swingback " as seen in this country. This Peruvian disease, known as " Renguera " is, Gaiger records, almost constantly associated with a micrococcus, but in the absence of success in all attempts to transmit the disease, either with the coccus or by means of body fluids, Gaiger states that it is impossible to say if this coccus is the causal agent. The presence of ticks have often been associated with nervous diseases in sheep, but ticks have never been observed on lambs which the writer has seen affected with " swingback."

There are two distinct types of " swingback." One type—the congenital type—is noted quite soon after the lamb is born. Such an animal may be unable to rise or suckle, although it appears otherwise fairly normal. Occasionally a lamb affected with this type may live for several days, and show muscular inco-ordination and general weakness of the hind quarters. So far no specimen of this type has been examined. The chronic type gives a more typical picture of " swingback." Symptoms may appear any time after ten to fourteen days, and consist of slight inco-ordination of movement and swaying of the hind quarters. Any kind of excitement aggravates the symptoms, when the affected lamb often falls over on its side, and for a time is unable to rise. Sometimes a

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" swingbacked " lamb can be seen walking with the fore limbs and dragging the hind limbs along the ground in an almost ludicrous manner. The appetite remains unimpaired, but as the disease progresses the affected animal becomes unable to travel far, so that it begins to lose condition. Finally, the lamb becomes unable to maintain its equilibrium posteriorly, and the paralysis may extend to the fore limbs before death. There is no loss of sensation in any part of the body, and no hyperæsthesia. The word paralysis has been used in a somewhat loose sense, but inasmuch as there is no loss of the power of movement or sensation, true paralysis is absent. The syndrome is merely inco-ordination of muscle groups (ataxia), and if an affected lamb is held by the fore legs, it kicks vigorously with it hind limbs, even although it is incapable of rising from the ground. At this stage " swingbacked " lambs are usually destroyed.

Post-mortem examination of typical cases of " swingback " has so far shown no special abnormality in any of the organs, and culture media seeded with material from heart blood, liver, kidneys, spleen, cerebro-spinal fluid, and brain substance, has remained constantly without observable bacterial growth. With regard to the pathological changes in the nervous system, the brains and spinal cords of two advanced and typical cases have been examined.

Case A.—A large, crossbred, single, male lamb, four weeks old. Had been affected with " swingback " for ten days, and was unable to rise. Killed by chloroform, and the brain and spinal cord were removed and placed in Muller's fluid. Segments of these tissues were then processed by Marchi's method, which deposits the black osmic oxide in nerve fibres in the early stages of degeneration. The acid does not affect normal nerve fibres, which assume the bichromate stain from the fixing fluid. First of all, sections of various parts of the cord, cerebral cortex, and medulla oblongata were made and examined. Tracts of degenerated nerve fibres were noted in the medulla oblongata as well as in the cord, being most noticeable in the thoracic region. The cerebral cortex appeared normal. The degenerated fibres of the spinal cord were in the position of the direct and the ventro-cerebellar tracts, while a little degeneration was also noted in the dorso-mesial column of Goll. Sections from the thoracic region of the cord were counter-stained with methyl blue, and upon examination showed what was probably an abnormal condition of the cells of Clarke's column in the grey matter. These cells took the stain unevenly, and had a granular and necrotic appearance.

Case B.—This animal was a crossbred, twin, female lamb, twenty-four day old. Affected with " swingback " for fourteen days, during which period it was closely observed. It continued to feed from a bottle, but became gradually weaker and unable to stand, and it exhibited muscular inco-ordination of the fore limbs. On the twenty-fourth day there was no true paralysis. Killed by chloroform ; brain and spinal cord removed and placed in Muller's fluid. Tracts of degenerated nerve fibres were again noted in the medulla oblongata and in certain regions of the cord. The degeneration was most marked in the thoracic part of the cord, where the ascending fibres are affected. Areas corresponding to

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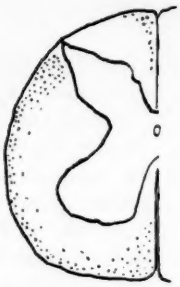

FIG. 1.—Case A. Upper Thoracic.

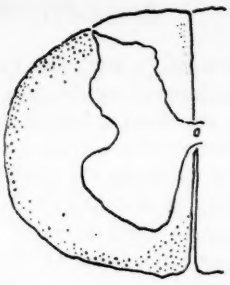

FIG. 4.—Case B. Upper Thoracic.

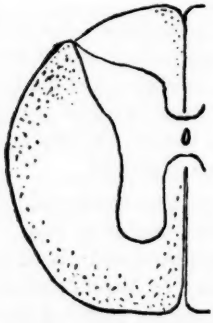

FIG. 2.—Case A. Mid Thoracic.

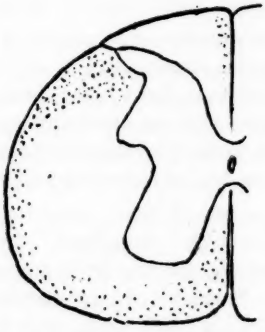

FIG. 5.—Case B. Mid Thoracic.

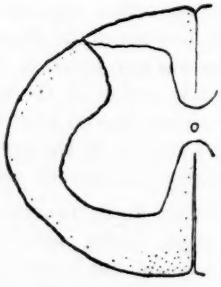

FIG. 3.—Case B. Lumbar region.

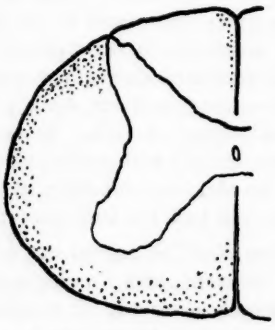

FIG. 6.—Case B. Lower Thoracic.

Diagrams indicating the principal degenerated areas. Goll's column is dorso-mesial; the direct cerebellar lies lateral to the dorsal horn of grey matter; the ventro-cerebellar tract continues round to the ventral fissure, occupying in part the position of the direct pyramidal tract which is absent in sheep.

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the direct cerebellar and ventro-cerebellar tracts, and to a lesser degree the dorso-mesial tract, showed degeneration, the whole picture resembling that given for Case A. The particular appearance of the cells of Clarke's column was also noted.

The foregoing consists of a brief description of the disease in lambs commonly known as " swingback," and a still briefer account of the pathological changes found in the nervous system of two typical cases. The columns of white matter in the spinal cord of domesticated animals have not all been clearly demarcated ; but referring the degenerated areas to known tracts, it would appear that the direct cerebellar and ventro-cerebellar tracts are principally involved, while the dorso-mesial tracts or column of Goll is affected to a lesser degree. There is also evidence of degenerative changes in the cells of Clarke's column of the grey matter. So far as can be detected, the pathological changes were confined to the ascending tracts ; the descending tracts appeared normal. The difficulties peculiar to the examination of nerve tissue, the absence of alternative and confirmatory methods and stains, the ever-present risk of artefacts, and the paucity of cases examined, precludes the possibility of drawing any but the most tentative of conclusions regarding the histological changes present in cases of " swingback." In spite of these very real difficulties, the suggestion that " swingback " is associated with degeneration of ascending tracts of nerve fibres in the spinal cord is interesting and suggestive, and will be taken as a working hypothesis and guide to further study. If it be assumed for the moment that the primary lesion in " swingback " is degeneration in the cells of Clarke's column, how, theoretically, would the consequential changes relate with the clinical picture ? The nerve fibres which end in arborisation with the cells of Clarke's column originate in the dorsal roots ganglia and carry impulses relating to unconscious muscle sense. From thence the nerve fibres have a threefold distribution. Some axons pass to the direct and ventro-cerebellar tracts on the same side, others cross the grey commissure and ascend in the ventro-cerebellar column of the opposite side. Unconscious muscle sense, or information concerning co-ordination of muscle tone in relation to posture and movement, is conveyed to the cells of Clarke's column. Consequently degeneration of these cells and their fibres would disorganise the machinery of muscular co-ordination, and this phenomenon does in fact actually constitute the principal symptom of the naturally occurring disease.

Goll's column is derived from dorsal nerve roots in the posterior half of the body, and its fibres carry impulses connected with conscious muscle sense, *i.e.*, information relating to the position of the limbs in space, and in degeneration the result is want of skill in using the hind limbs as well as the posterior part of the trunk. The dorsal roots have yet to be examined for the source of degeneration mentioned as occurring in the column of Goll.

The author gratefully records the assistance he has received in the investigation of these cases from Mr. John Secker, M.Sc., M.R.C.S., of the Physiological Department, University of Durham College of Medicine.

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THE SHEEP MAGGOT FLY.

By W. JACKSON YOUNG, F.R.C.V.S., D.V.S.M. Vict.
Newcastle-upon-Tyne.

In many districts this insect makes greater demand upon the time of flock masters and shepherds than all the other ailments of the flock combined. It is generally during close, muggy, thundery and showery weather that the fly is most troublesome, and May and June are considered to be the worst months. For some years observations have been made by the writer, and he has found sheep attacked as early as the first week of April, and as late as the third week of November.

During inspections of sheep and lambs in landing places, markets, and on farms, very many cases are encountered, and when engaged on such duties, veterinary surgeons should be capable of picking out animals that are attacked. They should also be conversant with the appearance of the skin after treatment has been applied, as this knowledge is of value in differentiating the lesion from that of suspected sheep scab. The writer has occasionally encountered the maggots of the blue-bottles (*Calliphora erythrocephala* and *Calliphora vomitoria*) on sheep, and is satisfied that such cases are very rare in comparison to those associated with the maggots of the green-bottle (*Lucilia sericata*).

Identification of Lucilia sericata.—The fly is about one-third of an inch long, golden-green in colour, with a bluish lustre and a whitish face. The forehead between the eyes in the male is not very narrow, and the eyes are separate. In the female the space between the eyes occupies one-third of the breadth of the head. There are three pairs of central bristles on the median forebody segment. The first two segments of the abdomen are blackish, and the third abdominal segment is comparatively small and hidden by long silky hairs. The proboscis is soft, and is not a piercing organ. The fly belongs to natural order *Diptera* ; sub-order, *Cyclorrapha* ; family, *Muscidæ*.

Life-history of Lucilia sericata.—The female deposits her eggs on the wool in clusters of from twelve to twenty. As many as a thousand eggs may be laid by one fly, and my records show that as many as two hundred can be deposited at one time. In summer the eggs hatch in from sixteen to twenty-four hours, and in cold weather up to three days. The maggots without delay seek the skin, and enter it by means of their mouth or hooks. They are fully grown in four days, and leave the sheep for pupation. The puparium stage varies from nine to twenty-one days. Dr. R. Stewart MacDougall (to whom the writer is indebted for much information) states that " in the most favourable conditions the life-cycle can be passed through in from twenty-five days to a month ; but cold or other unfavourable conditions may result in a considerable lengthening out of the cycle." This observer records that he collected maggots on August 14th, and that flies appeared up to late in December.

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Symptoms of Attack.—The " struck " sheep or lamb appears to be irritable or uneasy, and when feeding is frequently seen to stamp one hind leg. Very often a sheep is noticed with its head close to the ground, but making no attempt to feed, and moving on a few paces to stop, and move on again amongst apparently contented sheep. Occasionally it may turn and bite at the cuticle or other part. Looking back over the shoulders is a common symptom, and biting is especially seen in lambs. The attacked sheep seeks shade, and wags its tail in a very characteristic manner, and turns quickly. The writer considers that the various types of ovine tail-wags would make an interesting subject for the cinema. Those who have large numbers of sheep to inspect become acquainted with the wags for maggots, sheep scab, keds, defæcation, and foreign bodies lodged in the wool of the buttocks. The wool on the affected part shows a dirty greyish-black stain, and closer examination will reveal a sticky fluid with a peculiarly offensive odour. There is rapid loss of condition, and death soon follows if the sheep be neglected. Sheep of all breeds are liable to be attacked, but a certain amount of immunity is claimed for some breeds. This so-called immunity in all probability is due to the conformation of the breed, which makes the hind quarters less liable to staining with urine or fæces.

The wool in the region of the crutch becomes filthy, and there is no doubt that such sheep are a greater attraction to the fly than animals cleaner in that part. The fly is attracted to the sheep by the distinct odour arising from the fleece after rain, or on account of skin trouble, such as eczema or erysipelas. There is also a greater tendency to " scour staining " in showery weather. Any wound, however small, is an attraction, and sheep affected with foot-rot are liable to attack. The elbow region should be carefully inspected when foot-rot exists. The writer has found many cases of maggots on the face and occipital region. Maggots of this fly have also been found on cattle and horses.

Preventive and Remedial Measures.—Cleanliness is of primary importance. The judicious use of shears is indicated on the tails, and any parts soiled by discharges. The immunity that dipping brings is only fleeting, and the best results have followed the use of dips containing sulphur or polysulphides, but there is ample room for research regarding the best repellant. Many sheep have been found attacked after recent dipping in soiled dip. More attention should be paid to the paving of gathering and catching pens at dipping places. Experiments have been conducted with various fixed and essential oils added to dip, but without success. Greater care should be exercised over the disposal of the maggots rubbed out of fleeces and wounds. It is customary for them to be allowed to drop on to the ground, where they burrow and live for a considerable time.

A report issued by the Director of Veterinary Services in South Africa, dated August, 1931, states : " From numerous experiments, it is concluded that burying is an unsatisfactory method for disposal of carcases. Flies may emerge from a carcase containing full-grown maggots, buried at a depth of six feet." The same report also recommends the following remedial treatment : Cotton-seed oil,

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45 ; petrol, 40 ; pine tar oil, 10 ; carbolic acid, 10. Wounds or sores should be promptly treated. Practically every shepherd has his favourite dressing. In some districts " fly stones " are used, and they appear to consist chiefly of mercuric chloride. A mixture of rape oil, creosote, turpentine, and balsam of sulphur is satisfactory. In the Colonies, New Zealand and Australia, attempts are being made to diminish this pest by the liberation of blow-fly pupæ parasitised with the Braconid, *Alysia manducator*, Panz. The Braconids belong to a sub-family of *Hymenoptera*, and are parasitic on the larva of several flies. Traps baited with pieces of mutton are extensively used with success, and other means of attracting the flies from sheep should be considered. For many years the writer has recommended flock masters to nail the carcase of a rabbit, hare, or rook to a post. The flies lay eggs on the carcase, and birds soon consume the maggots as they emerge. There is good evidence also that the eradication of bracken diminishes this pest.

THE INTERNAL PARASITES OF SHEEP: A SURVEY.

By THOMAS W. M. CAMERON, M.A., D.Sc., M.R.C.V.S.

Lecturer in Helminthology in the University of Edinburgh ; and at the Royal (Dick) Veterinary College.

In general, the parasites of sheep are similar to those found in all ruminants. Certain differences do occur, of course, between those of the sheep and the ox; smaller differences occur between those of sheep and goat even ; but, on the whole, that generalisation is true. The importance is very different, however, when intensity and frequency of parasitic infections are concerned. There is no doubt that animal parasites play the major part in the causation of ovine disease, while they only have a minor part in bovine pathology, at least so far as this country is concerned. This is probably due in part to differences of host resistance and in part to different methods of feeding.

It must not be thought that actual deaths constitute the sole or even the greater source of loss to sheep owners. Far more expensive is the loss of condition and decreased productivity, and there is a steady and consistent drain in growth, wool, mutton, and lambs, which is so steady and consistent that it is unnoticed by the owner, who attributes his lack of profits to every cause except the true one. Wherever there is unthriftiness, lack of condition, poorness of coat, irregular action of the bowels, susceptibility to various minor ailments, it is wise to suspect animal parasites.

Sheep have always been important in Britain, and some of the diseases of sheep were known in the very earliest times. One of the earliest imports into this country was Archangel tar for the cure of the " scab " ; and the name " fluke " is derived from the Anglo-Saxon " floc," perpetuating the belief that the sheep had swallowed young flounders which had thereupon taken up their abode in the liver. In passing, it is interesting to recall that the French word for the same

parasite—la douve—is also the name for a grass growing in marshy places which was thought to become transformed into the parasite when eaten by the sheep. While these grosser parasites have been known for centuries, it is only in recent years that ovine parasitology has come into its own and developed into a highly involved and scientific branch of veterinary medicine.

The important sheep parasites are included in four phyla : protozoa, platyhelminthes, nemathelminthes, and arthropoda. The last group includes the mange mites, the ticks, the nostril flies, the keds, the lice, and the maggot flies, all of them ecto-parasites, which can be easily seen and appreciated by those who handle sheep. This survey will not include these forms, but will be confined to the other three groups which constitute the endo-parasites ; it will be more convenient, however, to treat them according to habitat rather than according to their strict zoological classification. More attention also will be paid to forms occurring in Britain than to those abroad.

In the blood we find trypanosomes, piroplasms, and blood flukes ; in the nervous system occurs the cystic stage of a dog tapeworm, while others are found in the muscles, abdominal cavity, and liver. In the latter habitat are also found the various notorious flukes. In the earlier parts of the alimentary tract occur several more or less harmless trematodes and nematodes ; in the abomasum and duodenum live the pathogenic threadworms ; in the small intestine are coccidia, tapeworms, hookworms, and a peculiar form of threadworm called Nematodirus ; in the large intestine, whipworms, Chabertia, and the nodular worms have their abode ; while in the lungs several important species of threadworms occur. This list is not exhaustive, but it does include most of the important forms.

Blood.—In the blood of sheep in various parts of the world occur three species of intercorpuscular parasites belonging to the genus *Babesia*. By their destruction of the cell they cause a hæmoglobinurea and a jaundice which is often fatal. The related genus *Theileria* is also represented in sheep as well as in cattle, and it also may cause a fatal disease. None of these parasites are present in Britain ; in fact we are still in ignorance of the actual distribution of the various species throughout the world, as it is only in very recent years that species have been differentiated, and all the old records attribute piroplasmosis in sheep to a single species. Control in all cases, of course, depends on control of the tick vectors.

The various species of pathogenic African trypanosomes, *T. vivax*, *T. congolense*, *T. brucei*, and their various varieties and strains, occur in sheep as they do in other mammals, but they are restricted to that continent because of the distribution of their fly vectors. The only trypanosome which has a wide distribution is the non-pathogenic *T. melophagium*, which is transmitted by the sheep ked. It occurs in over 80 per cent. of British sheep, but always in such small numbers that cultural methods are usually necessary to demonstrate its presence.

In the veins of the small and large intestine of sheep in the tropics and subtropics occur several species of blood flukes belonging to the genus *Schistosoma*,

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which may do a considerable amount of both local and general damage to their host. They are whitish trematodes, about ¾ in. long, separate sexed, with the female lying more or less permanently in a groove formed by the infolded edges of the male. The eggs are passed to the exterior in the droppings, or more rarely the urine, and develop into infective forms in various species of water snails. The infective cercaria which emerges, makes its way to the blood stream by penetrating the skin or the wall of the rumen after ingestion with water. Although at least one species occurs in southern Europe, none have ever been naturally found in Britain.

Brain.—The most serious animal parasite of the brain of sheep is *Cœnurus cerebralis*, the larval form of the common *Tænia multiceps* of the dog. It is widespread throughout the world, although it appears to be much less common in Britain than it was a hundred years ago. The tapeworm egg is passed on to pasture in the dog's droppings, is swallowed by the sheep, and the larva makes its way, *via* the blood stream, to the brain, where it develops into a thin-walled cyst about the size of a large egg, containing many tapeworm heads. It is possible that the similar cysts found in rabbits and goats in various parts of the world are really the same species as this. In these animals, the cysts do not occur in the central nervous system, but steps should be taken to destroy them when found, in order to prevent the possibility of infecting dogs with the tapeworm, so forming a reservoir for future infections of sheep. Treatment in the sheep is surgical, while a rational prophylaxis demands the periodic use of anthelmintics in dogs, especially sheep dogs, and the destruction of all infected offal.

Musculature.—In the muscles of sheep in various parts of the world occur the small cysts (about the size of a pea) which are the larval stages of *Tænia ovis*, another dog tape-worm. Heavy infections may have serious effects on the sheep, but their greatest importance lies in the fact that they closely resemble the cysts of the very serious human *Tænia solium*. There is no authentic record, however, of this parasite developing in sheep, and *Tænia ovis* will not develop in man. Prophylaxis again demands treatment of dogs and destruction of offal.

Liver.—This is equally true of the various tapeworm cysts found in or near the liver. The most important of these is the hydatid cyst, the elaborate larval stage of the minute *Echinococcus granulosus* of carnivores. The adult tapeworm will only live in carnivores, and preferably canidæ; but the cyst can develop in practically any species of mammal from man to marsupial. Nevertheless, the optimum host is the sheep, and the distribution of hydatid disease in the world exactly coincides with the distribution of sheep. Where many sheep occur, there hydatid cyst is common in man. This does not mean that man can be infected by eating the cyst in the liver of the sheep. He cannot. But where cysts are common in sheep, dogs are frequently infected, and so the chances of human infection are enormously increased. Man can only be infected by the tapeworm egg passed in the droppings of the dog, but the sheep may passively carry this egg to man. This appears to be the commonest method of infecting

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women and children in Iceland for example, where the ewes are herded together at certain seasons, and the wool quickly becomes soiled with dried dog's droppings. The dried eggs are passed on to the hands of those handling the sheep, and in this way a high rate of infection of man is maintained. The parasite is far from uncommon in Britain, and while the dog appears to be the most important source of human infection, in some parts at least, the fox appears to play the most important part in ovine infection. This makes it all the more important to destroy by heat or by disinfectant all infected offal.

In addition to the thick-walled large hydatid cyst, the liver is often the habitat of another tapeworm cyst, the thin-walled, single-headed *Cysticercus tenuicollis*. This cyst often drops out of the liver into the peritoneal cavity, and continues its development in the omentum. Like hydatid, this cyst may cause the death of the sheep through bleeding from the liver, but normally it does little if any damage. The most important parasites of the liver, from the point of view of the sheep, are the liver flukes. These belong to two different genera. The first of these is *Fasciola hepatica*, the most notorious of ovine parasites, and one which causes millions of pounds to be lost yearly. In tropical Africa it is often replaced by an elongated variety, generally regarded as a different species, called *Fasciola gigantica*, and in parts of North America by a large massive form called *F. magna*. All these species occasionally are found in the lungs, but their main importance is in causing a cirrhosis of the liver, accompanied by a pernicious anæmia, which unless treated often destroys the sheep. They play an often important secondary part in causing various bacterial diseases of the liver. The life cycles of all these species follow identical lines, and are so generally understood that detailed description is unnecessary. All pass their extra-mammalian life in various species of water snails (which just as often occur on land) of the genus *Limnæa*, and all parts of the world are infected. The infective cercaria which emerges from the snail encysts on grass, and is swallowed with the food; once inside the alimentary tract, it makes its way to the liver. Prophylaxis, which is much more important than cure, depends on snail eradication by copper sulphate, drainage, and birds, on fluke destruction in mammals by male-fern or carbon tetrachloride, and by fencing dangerous areas. In the West of Scotland, as well as in Europe, Asia, and elsewhere, is a much smaller species of liver-fluke called *Dicrocœlium dendriticum*. It is carried from sheep to sheep by a species of land snail, and its development in the snail is very different from that of *Fasciola*. The flukes cause much the same changes in the liver, but their toxic action is less pronounced. Prophylaxis is not yet practicable, as the life-history has only been understood for a year or so, and many details yet await solution.

Œsophagus.—In the œsophagus are found these peculiar little bodies called Meischer's tubes. They may reach five centimetres in length and are cylindrical or fusiform, white in colour, and filled with spores. They are called *Sarcocystis tenellæ*, but their systematic position and life-history are quite unknown. They enjoy the unique distinction of being the only known animal parasites to produce

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a true toxin in the bacterial sense, *i.e.*, a toxin causing the production of a specific antitoxin in the plasma of the host. Its other pathogenic properties, if any, are unknown. In some countries there is found in the sub-mucosa of the œsophagus several species of nematodes belonging to the genus *Gongylonema*. They lie in a perfectly regular curved zig-zag, and are non-pathogenic. They are carried from animal to animal by various species of dung beetle, but although the intermediate hosts are common in Britain, and the parasite occurs in southern Europe, it is absent here from sheep.

Rumen.—In the rumen, in addition to innumerable species of non-pathogenic ciliates, occur several species of Amphistome trematodes, little piriform parasites with a large posterior sucker, by means of which they adhere to the mucosa. In the rumen and reticulum they appear to be perfectly harmless, but they pass part of their parasitic existence embedded in the duodenal mucosa, and in that position they can do a considerable amount of damage. Their asexual life-cycle is passed in a water snail and apart from the species of snail involved, is identical with that of Fasciola. Their treatment is unknown, but carbon tetrachloride should be useful.

Abomasum and Duodenum.—The parasites found in the abomasum often overflow into the duodenum, and it is convenient to consider these two localities together. A considerable number of members of the nematode family Trichostrongylidæ is found here. The most obvious, and probably the best known, is *Hæmonchus contortus*, a red hair-like worm just over an inch in length. It is easily seen with the naked eye when the abomasum or duodenum is opened. As its colour suggests, it is an active blood-sucker, and perhaps the most pathogenic of this group. It is by no means the most common, however; in fact in Britain it is relatively rare. The common forms are the minute species belonging to the genera *Ostertagia, Trichostrongylus* and *Cooperia*. Of these, *Ostertagia* is the largest, but all are so small that they are generally overlooked on post-mortem examination. It is seldom that a single species is present, and collectively this group of parasites are among the most serious of those found in the alimentary tract. They are the main cause of the parasitic debility which is so often seen in lambs and undernourished sheep. Their life-cycles are all similar to each other, but no two are identical. A small oval egg—they all look alike—is passed in the droppings, and it hatches in a few days. The larva which emerges grows and moults, and in about a week becomes infective. At this stage it is ingested with food, and develops directly into an adult in the abomasum or duodenum. Hatching and development is slowed down in cold weather, but a fairly low temperature is required to kill the egg or the infective larva. Normally our winter merely suspends animation, and so leads to an artificial concentration of infective forms in spring, with a resulting super-infection of the young lambs. Moisture is essential for the development of the parasite outside of the body, so that hillside pastures are safer than low-lying valleys, and a sandy soil than a good loam. Treatment of *Hæmonchus* with copper sulphate, with or without arsenic or

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nicotine, gives good results, but the other parasites are much more difficult to cure. Good hygiene and good feeding with a well-balanced ration is the most satisfactory course to adopt.

Small Intestine.—In the small intestine are two other nematodes of considerable importance. The first of these, *Monodontus trigonocephalus*, is popularly known as the sheep hookworm, and is one of the most serious and widespread of all the parasites of sheep. Zoologically it is very closely related to the human hookworms, and these parasites are regarded as causing one of the four major diseases of mankind. Fortunately they are restricted to the tropics, and sub-tropics. When it is realised that the sheep hookworm, which is considerably larger than the human species, is as common in the North of Scotland as it is on the equator, it will be realised how serious the parasite can be. It is present in practically every adult sheep in Britain, fortunately in small numbers, too small to do much damage at present. Agriculture is continually making possible the maintenance of more and still more sheep on a limited area of ground, and if the situation is not carefully watched, the dangers from this and similar parasites will be considerable. The disease caused by the hookworm is an anæmia, the degree of which depends on the number of parasites present, as well as on the resistance of the host. The life-cycle is very similar to that of the stomach worms, and the same measures of prophylaxis should be adopted. The most satisfactory drug is probably carbon tetrachloride.

The other common nematode in this region is *Nematodirus*, a slender pink species about an inch long. They are specially common in lambs; in fact they probably are the commonest species found in lambs in Britain, sometimes occurring in enormous numbers. Unlike the previous species, the free life is not well adapted to a tropical life, and accordingly it is essentially a temperate species. This genus is unique among the group of nematodes to which we have just been referring, in that the egg is large and easily recognised under the microscope. There hatches from this egg, after about three weeks' incubation, a larva which is immediately infective. It is very resistant to adverse conditions, except heat, a fact which accounts for its temperate distribution. Theoretically at least, the egg of this species may be infective. This life-history makes prophylaxis even more difficult than usual, but it should follow on the same general lines as before. Treatment is not very satisfactory either, best results having been obtained with copper sulphate and nicotine.

The tapeworms of sheep mostly occur in the small intestine, although at least two species, *Stilesia hepatica* in Africa, and *Thysanosoma actinoides* in North America, are often found in the bile duct. The most conspicuous of the tapeworms are the two species of *Moniezia*, which often reach a length of several yards. There is no evidence that they ever do any serious damage to their host beyond a mechanical impaction when they are very numerous. They may also interfere with calcium metabolism, but this is still unknown. The life-cycles

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of all the tapeworms of sheep are still unknown, and so prophylaxis is impossible. The most satisfactory drugs are copper sulphate and male fern.

The remaining important parasites of the small intestine are the Coccidia. There may be several species of the genus *Eimeria* in the small intestine, and one at least is far from uncommon. Normally it seems to do little beyond local damage, but on occasion it can cause an extensive erosion of the mucosa, and so cause a severe and often fatal dysentery.

Large Intestine.—In the large intestine are commonly found three genera of nematodes: the relatively innocuous whipworm, and the more serious *Chabertia* and *Œsophagostomum*. The whipworm is found with its long, thin neck laced into the mucosa, and the thick body projecting into its lumen. It has never been associated with any disease in sheep, although it is possible that the lesion which it makes may permit of the introduction of bacteria which otherwise could not invade the body. *Chabertia*, which somewhat resembles the hookworm of the small intestine, can be recognised by its large mouth capsule. It is usually a blood sucker, but its pathology has been little studied. Its life cycle is very similar to that of the hookworms. Treatment is not well known, but carbon tetrachloride should be effective.

The genus *Œsophagostomum* contains a number of species which are quite harmless, as well as the very pathogenic *O. columbianum*, the cause of "pimply-gut." It is fortunately a rare parasite so far as Britain is concerned, but it is of great importance in some of the warmer parts of the world, including South Africa. The larvæ live in the wall of the intestine, and give rise to extensive degenerative changes which appear as nodules on the mucosa. In lambs, these often become confluent, and cause an enormous thickening of the whole tract, with a considerable mortality. Prophylaxis is on similar lines to those suggested above. The raising of lambs on grassless paddocks, food and water being given from raised troughs, gives very satisfactory results, but obviously is not of general application. Treatment is not yet satisfactory, but promising results have been obtained with enemata of copper sulphate and arsenic. As in all these worm infections, diet and nursing are of the utmost importance.

Lungs.—The parasites of the lungs form a more difficult group to discuss, and we can only refer to them very briefly here. In the bronchi, live the longish, white *Dictyocaulus filaria*, which cause the disease known as husk. In the alveoli and bronchioles is found the smaller, reddish *Protostrongylus rufescens*, but it is a somewhat uncommon parasite, in this country at least. The commonest species found is *Muellerius capillaris*, the cause of pseudo-tuberculosis. It is difficult to say whether the habitat of this species is the pulmonary capillaries or the lung tissue, as it is generally found in the centre of a caseating mass. Although present in almost all adult sheep in Britain to some extent, it is doubtful if it does much real damage. The life-history of *Dictyocaulus* is a direct one, and infection is by swallowing the infective larva as a contamination of food or water. The larva penetrates the intestinal tract and reaches the lung by way

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of the lymphatic system. *Muellerius* involves a molluscan intermediary in reaching a new host, the snail being swallowed with grass. Many different species of snail can serve in this capacity, and the frequency with which the parasite occurs in sheep, testifies to the frequency with which snails are "accidentally" swallowed. The life-cycle of *Prostostrongylus* is unknown. *Dictyocaulus* causes disease by mechanically obstructing the breathing tubes, and anthelmintics are generally given by intratracheal injection. The drugs used are intended to kill or stupify the worm, which is then coughed up and swallowed by the sheep. The drugs used are legion, but the best appear to belong to the phenol series ; none is absolutely satisfactory, and most reliance should be placed on feeding and nursing. Treatment of the other forms is quite unknown, and nursing is the only course.

General.—This brief survey is far from being exhaustive, and mention has been made only of the commoner or more important of the internal parasites of sheep. Not all of those are amenable to anthelmintic treatment, and diet and nursing play a most important part in all cures as well as in all prophylaxis. It is important to remember that all anthelmintics are more or less poisonous to the host as well as to the parasite. A considerable degree of debility, including the debility due to superparasitism, is a contraindication to the use of anthelmintics, and it is important that anthelmintics should only be administered under strict veterinary supervision. A great deal of damage can be done by one inexperienced in their use ; often more damage is done by the drug than by the parasite, and it would be well if some of the more toxic drugs (including carbon tetrachloride) were restricted in their sale in a similar manner to that proposed for biologics. The ideal to be aimed at in all parasitic infections is prevention, however, and while treatment must remain under the control of the veterinary surgeon, the stock owner is the correct person to apply prophylactic measures. He has a right to expect his veterinary adviser to advise him on the measures to be adopted, however, and some of these may be briefly summarised here.

Young animals are as a rule much more susceptible to the effects of parasitism than are adults ; the important reversal of this rule is the Babesias, where the lamb is more resistant than the sheep. Protection must be arranged accordingly : young animals must be protected from helminths where measures are limited, older animals from ticks. Pasture rotation theoretically will control helminths, but it is not generally applicable. Efforts can be made to reserve accommodation for the lambs, however, even if the ewes are exposed to infection. Permanent pastures are specially dangerous, and are the greatest single factor favouring infection. Bare lots, as mentioned above, can be used if no alternative pasture is available. Rotation of stock is of great use, especially if the farmer can alternate with horses or pigs ; cattle are rather more dangerous, as they suffer from many of the same parasites as do sheep. Mixing of stock in a single field is another useful measure, as the parasites are not interchangeable. Horses are an excellent mixture with sheep for this purpose ; the horses eat the sheep-worm larvæ and digest them, while the reverse service is performed by the sheep, and both have the

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numbers kept down. Under certain circumstances burning of long grass is desirable, sheep will not eat it in any case, and the fresh young grass which comes up is much more nourishing, and therefore provides much greater protection. The use of forage crops is often good. Keeping lambs away from pasture at night, and until the dew is off the grass, reduces the infection of both animal and pasture.

Dosing of apparently healthy sheep which are carrying too few parasites to cause disease is a useful method of control, and should be practised periodically, especially in autumn and winter.

Drainage is always useful. Not only does it improve the pasture, but it removes the moisture necessary for the development of both snails and larval nematodes. Snail eradication is, of course, of great importance in fluky areas. Dips are essential to control the other vectors, as well as those forms which are ecto-parasites only.

Dogs, especially sheep dogs, must be kept free from tapeworms, and all sheep offal should be either burned or cooked well before being fed to animals.

In the great majority of cases the droppings carry the egg or larva, which, after a period of development, will be ready to return to a sheep. Prophylaxis, therefore, should concentrate on preventing this development and return, and making the animal more fit to withstand the parasites when they do return. The first two steps demand a knowledge of the habits of individual parasites, the last a knowledge of the scientific principles of dietetics and of general hygiene.

OVINE ANTE- AND POST-PARTUM PARALYSIS.

By L. C. MAGUIRE, F.R.C.V.S.
Stow-in-the-Wold.

THE disease first came to my notice in this district about six years ago, and was then seen in sheep brought from hilly districts, such as Wales, Scotland, and the northern counties of England. In later years it has become much more prevalent and widespread, and attacks all breeds of sheep. It is only seen in the pregnant ewe or very soon after lambing. The ante-partum condition generally manifests itself any time within three week previous to lambing, whereas the post-partum condition generally attacks ewes within a week after lambing.

Cause.—Without having any actual proof of the cause of this disease, I believe it is due to an auto-intoxication, together with a deficiency of minerals in the system. The pathological changes are, I believe, due to a hydration or gelato-hydration of the protein particles of the blood in the splanchnic area, the result being a precipitation of these particles in the arterioles and capillaries of this area, the organ which suffers most being the liver.

Two conditions may be responsible for this: (1) The toxins which are normally present in the animal's system during pregnancy; (2) a deficiency of lime salts in the blood. The salts of calcium are known to be very potent dehydrators of

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hydrated and precipitated protein particles. Auto-intoxication, no matter from what source, always produces hydration or gelato-hydration of protein particles. As there is always a certain amount of auto-intoxication in pregnant animals, and it increases as gestation advances, reaching its culmination about the time of parturition, it, therefore, follows that if lime salts, which act as neutralising agents of this intoxication, are deficient, the natural sequence of events is that the intoxication will advance to the stage where it brings about hydration, and a consequent precipitation of the protein particles of the blood stream.

Post-mortem examination of victims of this disease reveals a more or less emaciated condition of the carcase, with a constant feature of fatty infiltration of the liver; more rarely the kidneys and spleen are involved. From a naked-eye examination of the pancreas it, too, seems to have undergone considerable alteration. Recently I have made numerous tests for the determination of the amount of calcium carbonate and calcium phosphate in the soil and water on farms in this district. In every case there was either none at all or very little in the soil, whereas in every instance an abnormal amount was found in the water, that from some farms yielding as much as thirty-six grains of calcium to the gallon; six grains to the gallon being the maximum amount which is not injurious to health.

Treatment.—A line of treatment which I have found very effective in preventing the disease is to supply the sheep with half ounce mixed minerals daily, commencing six weeks previous to the date of lambing. The mineral is mixed with a daily ration of crushed oats and bran. I think this is a better method of administering the mineral than leaving mineral bricks to be licked at the animal's discretion, for with the former method one knows that the animal has received the prescribed quantity if she eats up her food. By adopting this line of treatment on farms where the disease was very prevalent, it has now been completely eradicated.

VACCINATION OF EWES FOR CONTAGIOUS DYSENTERY IN LAMBS.

By KENNETH A. MILES, M.R.C.V.S.

Husbands Bosworth.

OWING to extensive losses from contagious dysentery in lambs (approximately 30 per cent. of the lambs born) in a mixed flock of sheep during the two previous lambing seasons, 200 ewes were vaccinated with Burroughs Wellcome Lamb Dysentery Prophylactic Vaccine in the season 1930–31. The procedure was to vaccinate the ewes twice, *i.e.*, ten days before tupping time, and about ten days before lambing was due to commence. The best site for injection is in the under surface of the tail, as then the ewe can be vaccinated in the standing position, and there is no wool to clip off. It is advisable to get the farmer to " tag " his sheep just before the injections. With two good assistants these sheep were injected in about two and a-half hours.

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This treatment was very successful, as no deaths amongst the lambs of this flock could be attributed to lamb dysentery. In fact, at weaning time, the owner averaged one and three-quarter lambs per ewe. Owing to the fall in prices of sheep, and the farming depression generally, no vaccination has been carried out this year. It will be interesting to see if the disease reasserts itself. The farmer, of course, knows that he can avail himself of Burroughs Wellcome serum for subcutaneous injection into each lamb, should necessity arise. This method is, of course, more costly and laborious, as there will be at least 300 lambs to inject, as against 200 ewes to vaccinate. The cost of one dose of lamb serum about equals the cost of two doses of vaccine for the ewe.

AN OUTBREAK OF FLUKE DISEASE IN SHEEP.

By H. M. HOLLAND, F.R.C.V.S.
Keighley.

ALTHOUGH fluke disease has taken a heavier than usual toll amongst the Swaledale, Scotch, Wensleydale, Masham, and other West Riding sheep, it has hardly ranked for comparison with the losses sustained in the other Ridings. Of course, most of the West Riding sheep live at higher altitudes, and this no doubt provides a probable solution of the great variation in percentage of loss by death from fluke disease. On March 7th, I was asked to investigate an outbreak of disease amongst a flock of 150 Swaledale ewes running on a moorland farm in the west of the West Riding. Out of this number, at the date of my visit, 23 had already died, and several more lay ill. Death took place (so the owner informed me) within twenty-four to forty-eight hours of the sheep being noticed to be ill. The initial stage of the illness was characterised by an inclination of the sheep to wander to an isolated part of the moor away from the flock. There it would cease grazing, become dull, and lapse into a state of coma, with accompanying stertorous breathing, frothing at the mouth, and death. I saw and examined several of the affected sheep, which no doubt have since died, in various stages of the illness, and confirmed the owner's description of the symptoms. I made a post-mortem examination of four ewes, and in each case I found long-standing fluke disease, with all the usual appearances of a chronic condition: the wall of the bile ducts being very considerably thickened, with fibrous extensions into the liver substance, and very few parasites such as one frequently finds amongst sheep reared on a fluke-infested farm where annual treatment is carried out with the usual remedy. Had I not dealt with outbreaks of a similar type during the last three months, I should have been puzzled to account for the large number of deaths amongst this flock, for amongst " fit " sheep fluke disease, as generally recognised, is not attended with more than a small percentage of fatalities.

Examination of the chest cavity revealed in each sheep copious exudation, very firm consolidation of the anterior half of each lung, which, when cut, presented an appearance not unlike the " marbling " in croupous pneumonia, made

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up in part with light-grey or necrotic-looking patches about the size of a sixpence, interspersed in the consolidated area, and pericarditis.

Of the 150 sheep on this farm, 50, it has since transpired, were reared on a fluke-infested farm in the north of the West Riding, and had received annual treatment for the disease. They were purchased about three weeks prior to my visit as " fit " sheep by their present owner—an experienced sheep man. Unfortunately he did not learn at the time of purchase that their place of origin was fluke infested. Twenty-two of the deaths occurred amongst the fifty, and only one doubtful amongst the remaining 100, which were bred on premises free from fluke infestation. I have dealt with outbreaks of illness similar to this during the last three months, and in each case the history of purchase was always the same, and the symptoms of illness and post-mortem appearances identical. It would therefore appear that sheep bred and reared on a fluke-infested farm, and given treatment, can thrive in this environment, but if moved to unsuitable or richer pastures, such movement is sometimes attended with heavy mortality, due to the development of a secondary pneumonia.

NOTE ON A TRICHOMONAS SP. CULTIVATED FROM THE GUT OF A SHEEP. DITRICHOMONAS OVIS (Nov. Sp.).

By ANDREW ROBERTSON, M.B., Ch.B.

Lecturer and Milner Fellow, Department of Protozoology, London School of Hygiene and Tropical Medicine.

Material.

SPECIMENS of the gut contents of eighty-six sheep (mostly lambs) were obtained from the London abattoir and other sources for the purpose of studying the coccidia parasitic in these animals. In one instance only a flagellate was found belonging to the genus *Trichomonas*, and this, because of certain morphological pecularities, is deemed worthy of special mention.

Cultivation.

It was far from easy to get this organism established in culture on the media commonly used for the cultivation of the human intestinal protozoa on which the species of *Trichomonas*, parasitic in man, grow easily and abundantly. In the first instance growth was obtained on an agar slope covered with Tanabe's (1925) fluid, made up as follows: Agar agar, 14 grams; sodium chloride, 6 grams; distilled water, 900 c.c.

Tanabe's fluid: Sodium chloride, 0.7 gram; sodium citrate, 1.0 gram; distilled water, 100 c.c.; Loeffler's dehydrated blood serum, 0.5 gram; white of egg, 2 c.c.

The sodium chloride and sodium citrate are dissolved in the distilled water, and the solution is boiled for ten minutes. It is then cooled to 40° C., when

the Loeffler's dehydrated blood serum is added and dissolved. Finally, the solution is allowed to cool to room temperature, when the white of egg is added. On this medium growth was very slow, and indeed, in the beginning, the mortality seemed to more than counterbalance the increase. The question of temperature seems to be an important one, for no growth was obtained in cultures incubated at less than 37° C., and further, in specimens withdrawn from the tubes for microscopical examination, death of the organisms, or at least cessation of movement, took place sometimes in less than half an hour. It is possible that better results might be obtained by incubation at a temperature slightly higher than 37° C. ; this, however, has not been tried, as an incubator working at such a temperature was not immediately available.

Attempts to establish the organism on liver infusion agar slopes covered with serum saline solution, or on Loeffler's blood-serum slopes covered with Ringer-egg fluid, were unsuccessful. In the former the survival was of longer duration, but the organisms gradually dwindled in numbers.

The addition of rice starch to the original agar slopes with Tanabe's fluid was a decided improvement in that it appeared to hold in check the bacterial overgrowth, and also afterwards there was a change in the prevailing type of bacteria present. Still, however, the results were disappointing, and it was only after a few drops of a glucose solution (the actual amount does not seem to matter) were added, that a copious growth was obtained. The length of survival in such Tanabe-agar-rice-starch-glucose tubes increased from two or three days to seven or eight, and in two instances the organisms were still living after fourteen days ; but even so, if subcultures were not made in about three, or at most four, days, recovery from the injury thus caused took about two to three weeks to overcome.

A series of experiments were carried out to determine the effect of the pH of the Tanabe's fluid on the cultures, and tubes varying between pH 6.8 and 8.0 were inoculated. It was found that survival was longest in tubes of pH 6.8, and it is probable that the optimum for the growth of this parasite is pH 6.8 or 7.

Size.

Because of the difficulty of obtaining good stained specimens, and because of the distortions bound to result from fixation, whether wet or dry, observations on size and shape were carried out on fresh, unfixed and unstained preparations, either by direct or dark ground illumination. The majority of the organisms were slightly ovoid or very nearly spherical in shape. Very rarely were they pointed posteriorly, and there was no indication of a caudal prolongation. The shape tended to remain relatively constant, and while alterations in shape did take place, most commonly as a result of external circumstances, nothing was seen to indicate the possibility of amœboid movement. Very shortly after withdrawal from the culture tube (the phenomenon may actually have been present before such withdrawal) the flagellates developed a degree of adhesiveness. As a result it was not uncommon to find practically all the flagellates in a prepara-

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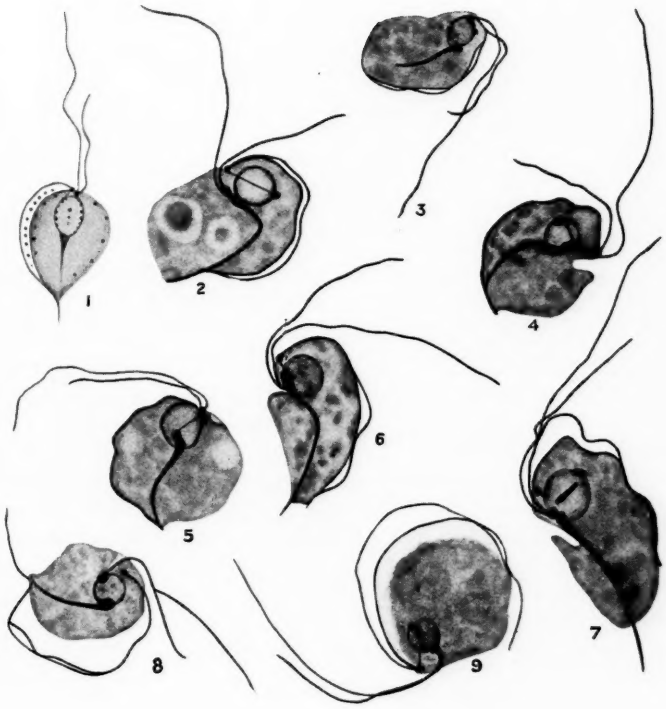

DITRICHOMONAS OVIS (Nov. Sp.)

Cultural forms drawn at a magnification of × 3,000 approx.

Fig. 1, wet fixed and stained with Heidenhain's iron hæmatoxylin. Figs. 2–9, dry smear preparations stained with Giemsa's stain.

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tion with numbers of bacteria plastered all over the bodies, but more frequently towards the posterior ends. They would stick also, but less frequently, to particles of rice starch, and to the coverslip and slide.

Altogether 363 flagellates were measured from cultures, and the ratio length : width was calculated. The results were as follows :

Ratio: $\frac{\text{Length}}{\text{width}}$	
1.0 (*i.e.*, round)	60
1.1	36
1.2	59
1.3	72
1.4	49
1.5	27
1.6	15
1.7	12
1.8	2
1.9	4
2.0 or above	7

It will be seen from the above table that longer, narrower forms with a length : width ratio of more than 1.5 were comparatively rare, and that the majority lay between 1.0 (round) and 1.3 or 1.4. Of the 363 individuals measured, 75 had lengths between 4μ and 5μ, 128 between 5μ and 6μ, and 73 between 6μ and 7μ. Few were under 4μ in length. As regards width, 92 were between 3μ and 4μ, 164 between 4μ and 5μ, and 59 between 5μ and 6μ. It may be stated, therefore, that the width of the majority lies between 3μ and 6μ, and the length between 4μ and 7μ, and it is probable that larger forms than the figures quoted are in the preliminary stages of division. As regards the extremes of size, the measurements of the six smallest and the six largest are as follows :

SMALLEST MICRONS.

Length.	Width.
3.6	2.9
3.8	2.8
3.3 round	—
3.4 round	—
3.7 round	—
3.9	3.4

LARGEST MICRONS.

14.5	8.0
11.3	5.7
10.9	7.6
10.7	9.5
10.4	7.3
10.3	7.8

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Morphology.

Owing to the extremely small size of the organism, accurate morphological observations were made only with the utmost difficulty, and this difficulty was further increased, firstly, by the shrinkage due to wet fixation, which was probably as much as one-third of the total bulk ; and, secondly, to the enormous distortion due to dry fixation. In addition, wet-fixed preparations were not easily made, because the fluid culture medium would not stick to the slide. It was found that the best stained preparations were those which were wet fixed in Bouin's picric acid, acetic acid, formalin solution, and stained with Heidenhain's iron hæmatoxylin (Fig. 1). For the details of the structure of the blepharoplasts and their connections, dry-fixed specimens stained with Giemsa's solution had to be used, since with wet fixation and staining their size was so small that they could only rarely be resolved even with the highest powers of the microscope (Figs. 2–9). The axostyles, too, could only be seen in dry-fixed smears.

With wet fixation the nucleus was round, or rather more frequently slightly oval, with a number of granules arranged along the sides of the oval (Fig. 1). There were a number of loosely arranged granules in the centre. Dry fixed, the nucleus was round, and stained practically a homogeneous pink with Giemsa's stain (Figs. 2–9).

The lateral flagellum arose from a blepharoplast at the anterior end of the body, and passed down the side of the body, either almost straight or definitely in spiral fashion, to the posterior end, to become free for a variable distance. The basal filament or chromatinic line took origin in the same blepharoplast, and appeared to be considerably thicker than the flagellum itself. The undulating membrane, in comparison with that of other species of *Trichomonas*, as a rule was very poorly developed, with the result that, in stained preparations, the lateral flagellum and basal filament appeared to be closely applied to each other (Figs. 2, 3, 4, 5 and 6). In wet-fixed films a number of comparatively large granules (Fig. 1) were arranged along the length of the basal filament, but these were not present in dry-fixed films.

The anterior flagella were two in number (Figs. 1–9). Only on very rare occasions were more to be seen, and under such circumstances the organisms unquestionably were in various stages of division. Of the two flagella, one was much longer than the other. The shorter flagellum was thicker and stouter, and varied from about one-third to two-thirds the length of the longer, thinner flagellum. The flagella lay side by side with the longer next to the blepharoplast of the lateral flagellum and undulating membrane (Figs. 1 and 6). The two anterior flagella curved round the anterior part of the body, and were inserted into a dot or blepharoplast which appeared to be situated on the lateral aspect of the nuclear membrane (Figs. 2, 3, 4, 6, 7, 8 and 9). Just alongside the point of entry of the anterior flagella into the body (Figs. 4, 5, 6, 7 and 8) there seemed to be a small opening into the cytoplasm. This was apparent in stained preparations only, and may possibly represent a cytostome or mouth. On the other

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hand, no indication of such an opening in this situation could be made out in the fresh, even when carefully studied with dark-ground illumination.

Lying close to the blepharoplast of the anterior flagella was another blepharoplast or similar structure. These two dots often gave the impression of being fused together (Figs. 2, 4, 6 and 7), but at other times they were quite distinct (Figs. 3, 5, 8 and 9). From the blepharoplast in question arose the axostyle. This structure usually curved fairly sharply at the beginning, but thereafter pursued a straight course to the posterior end (Figs. 2, 4 and 6). Sometimes, as seen in the fresh, it projected for a considerable distance beyond the body, but more frequently no projection was visible.

Lying on the side of the nucleus, away from the blepharoplasts of the anterior and lateral flagella and the axostyle, was a fourth dot (Figs. 2, 3, 4, 5, 7 and 9). This probably was in the nature of a parabasal body such as has been described by Grassé (1926) and others in different species of *Trichomonas*. Between the parabasal body and the blepharoplast of the lateral flagellum there was a sharply defined but very thin filament (Figs. 2, 4, 5, 6 and 9). It seems likely that, in addition to this filament, there are others present, linking up the three blepharoplasts and the parabasal body into a sort of a "system," but since the small size precluded any degree of certainty in this matter, no definite statement can be made.

The cytoplasm tended to be homogeneous, and granules were not a marked feature. Inclusions, too, were not of common occurrence, but occasionally granules of rice starch were found in the interior (Fig. 2). Ingested bacteria were conspicuous by their absence. This absence of solid food particles within the body might be accounted for by the nutrient character of the medium, which might permit of feeding by osmosis.

Lastly, there was nothing particularly diagnostic about the movement of the organism as a whole. It tended to be jerky and indeterminate in character, and might result in progression straight forward, or in any direction, with this proviso, that as a result of the spiral inclination of the lateral flagellum and undulating membrane, the body itself was forced to rotate practically all the time. The posterior or free part of the lateral flagellum was of variable length, and even when the lateral part was undulating, might merely trail behind, as it were, to steady the body. When it did take part in propulsion it swept round, completing a wide circle, thus providing a powerful forward thrust, especially noticeable when the flagellum was in contact with a solid mass (*e.g.*, of starch or other debris).

As has been noted above, the two anterior flagella were of unequal length (Figs. 1–9). The longer, thinner flagellum was about twice to three times the length of the body. It varied from about 12μ to 16.5μ, while the smaller was from 7.5μ to 10.5μ. They often gave the impression, and this was more marked the quicker the movement, of taking origin from a common stalk. While they might act independently of each other, this was the exception and not the rule ; indeed,

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there seemed to be a definite correlation between the movements of all the flagella, including the lateral flagellum and undulating membrane. The usual tendency was for the two anterior flagella to work in the same plane. Taking first the longer flagellum, this was pushed out straight in front, and this was followed by a bending or curving round of the tip as if it were " clutching " at something. The whole flagellum then struck sharply backwards in the direction of the undulating membrane. The shorter flagellum followed very soon after the longer. It sometimes showed the " clutching " type of movement, but not so frequently, and also it was more often slightly curved on itself, whereas the longer flagellum was nearly straight. This shorter flagellum struck just after the longer flagellum, but in the opposite direction, *i.e.*, away from the lateral flagellum.

Discussion.

The only references which have been found in the literature to *Trichomonas* in sheep are those of Fantham (1920), and Braune (1913). The former noted the presence of a *Trichomonas*, probably *T. ruminantium* of Braune, in the reticulum of three sheep and one ox, but did not describe nor figure the organisms. Braune (1913), when creating the species *Trichomonas ruminantium*, gave the number of anterior flagella as three, all of equal length. From Braune's description and his drawing of *Trichomonas ruminantium*, it would appear that beyond a certain similarity in size, *T. ruminantium* had little in common with the organism at present in question. According to the observations of Grassé (1926), each species of *Trichomonas* has a definite number of flagella. If this is the case, and there seems every reason to suppose it is correct, *T. ruminantium*, with its three anterior flagella, must belong to a species distinct from the one under discussion.

Grassé, in the same paper, raises another point of interest. He states as follows : " Remarquons que l'unique représentant du sous-genre *Ditrichomonas* : *D. Immsi* (Dub. et Gras.) (=*D. termitis* de Imms) vit dans le rectum d'un Termite *l'Archotermopsis Wroughtoni* et ne diffère de *Pseudotrypanosoma giganteum* de Grassi que par la possession d'un axostyle. Peut-etre, faudra-t-il créer un nouveau genre pour cette espece vraiment à part."

It is not intended to open up the question of the validity or otherwise of the sub-genus *Ditrichomonas*, but, since it has been the practice in the past to subdivide the genus *Trichomonas* into sub-genera on the basis of the number of anterior flagella, for the present at least the sub-genus *Ditrichomonas* will be retained. Accordingly, since the flagellate described above appears to be a hitherto undescribed species, it is proposed that it shall be named *Ditrichomonas ovis* nov. sp.

Since the foregoing was written, attention has been drawn to a paper by Knowles, R. and Das Gupta, B. M., on "Two Intestinal Mastigophora from an India bull," in the *Indian Journal of Medical Research*, Vol. XVIII, No. 4, April, 1931, pp. 1–11, in which the authors describe two flagellates, *viz.* : *Embadomonas ruminantium* Knowles and Das Gupta, 1931, and *Trichomonas ruminantium*

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Braune, 1913. From the size, 11μ to 16μ in length, and 5μ to 10μ in width, and the fact that their *Trichomonas ruminantium* had three delicate anterior flagella, though one appeared to be much shorter than the other two, it can be concluded that they were dealing with an organism specifically distinct from *Ditrichomonas ovis*.

REFERENCES.

Braune, R. (1913): "Untersuchungen über die im Wiederkäuermagen vorkommenden Protozoen." *Arch. f. Protist.*, Vol. XXXII, p. 111.

Fantham, H. B. (1920): "Some parasitic protozoa found in South Africa—III." *South African Jour. Sci.*, Vol. XVI., November, p. 185.

Grassé, P. P. (1926): "Contribution à l'étude des flagellés parasites." *Arch. Zool. Exper. Gen.*, Vol. LXV, December, pp. 345–602.

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SOME AILMENTS OF SHEEP IN NEW ZEALAND.

By H. A. REID, F.R.C.V.S., D.V.H., F.R.S.E.

Late Officer in Charge of the Veterinary Laboratory, Department of Agriculture, New Zealand.

IT is helpful, when considering some of the ailments encountered among sheep in New Zealand, to be able to form some conception of the country as regards its physical characters. In common with all countries of volcanic origin, New Zealand presents a very irregular appearance. In the North Island, mountains occupy approximately one-tenth of the surface. Still more mountainous is the South Island, where almost along its entire length run the Southern Alps, culminating in the highest peak in new Zealand—Mount Cook (12,249 feet). There are, however, in the South Island extensive plains—the Canterbury Plains—admirably adapted for cereal cultivation, and also grazing purposes.

New Zealand has a plentiful and well distributed rainfall, and, as one would expect, the country generally is well watered, rivers providing a characteristic feature of the landscape. The climate is equable. The mean temperature at sea level varies from about 62° F. in the north, to about 50° F. in the far south. These temperate conditions ensure a growth of herbage practically the whole year round. There are few, if any, native deciduous trees.

Situated in mid-ocean, and separated from the Australian Continent by 1,200 miles of open sea, New Zealand for the greater part of the year is swept by winds chiefly from the west. The winds are more persistent and attain their greatest velocity in the early part of the year and during summer. While perhaps adding to its hygienic qualities, the predominance of wind mitigates to a large extent the otherwise agreeable nature of the climate, at least from the human standpoint.

From the preceding references it will be gathered that the country offers ideal conditions for pastoralists. The sheep flocks alone number over twenty-nine million. Its isolated position, its comparatively recent occupation, dating

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from 1840, and the rigorous precautions enforced against the possible introduction of disease, render New Zealand, so far as infective processes are concerned, one of the healthiest countries in the world.

Unfortunately, this relative immunity does not extend to other ailments dependent upon intrinsic factors, such, for instance, as certain of the deficiency diseases affecting areas in all probability more widely distributed than are at present recognised. Comprehensive soil and pasture analyses, as well as systematic biochemical investigations, are now being undertaken in New Zealand. The results are likely to prove interesting. New Zealand soils are, speaking generally, deficient in lime and phosphorus, and to a varying extent other essential minerals and elemental constituents, including iron and iodine. In certain restricted areas minerals are unequally distributed, and an excess of manganese may coincide with a deficiency of iron, or interfere with its assimilation.

Biochemical observations have shown that factors which limit the assimilation of calcium proceeding either from an absolute deficiency of the mineral or defective metabolism, have a preponderant influence in initiating disease. Up to the present the effect of the calcium balance of the blood and body tissues in relation to disease processes has not been definitely assessed, but the general trend of these observations, so far as they have gone, seems to point to calcium as being of vital importance to the well-being of the organism. Any decline in the normal calcium content of the blood may in itself induce some functional disability of the endocrine gland system, and either inaugurate a toxæmia or provide a more suitable seed bed for microbic activities. In similar manner, a deficiency of iodine depresses the efficiency of the thyroid gland by inhibiting the secretion of thyroxin, which in its turn appears to provide one of the main defences against infections.

As time goes on, more attention will be devoted to this phase of the question, as being not less important than the specific virus. One can picture the future research worker beginning his labours on the state of the body tissues as affected by nutrition rather than, as at present, on the discovery of a specific infective organism with its concomitants of serum, vaccine, and similar artificial means of creating an immunity which has yielded under circumstances as yet not properly understood.

The rôle played by vitamins, although important in relation to human disease, and to a lesser degree to animals maintained under artificial conditions, does not affect New Zealand, where farm animals, particularly sheep, rarely receive other than fresh foods in the shape of natural herbage, roots, and the usual fattening crops.

In connection with the ailments affecting sheep in New Zealand, those definitely attributable to mineral deficiencies are of interest. Perhaps the most widely known of these is the so-called iron hunger or "Bush Disease," which occurs upon the pumice soils of the latent volcanic areas of the North Island. The outstanding features of this complaint have frequently been described. Briefly,

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they consist of an inability on the part of ruminants depastured in these localities to thrive amidst abundance of natural food. Susceptible animals suffer from progressive emaciation and anæmia if kept for many months upon lands which are " bush sick " as it is called. Investigations into the nature of this malady have proved that it arises through lack of iron in an assimilable form in the soil, and hence in the herbage. The complaint is amenable to treatment by means of the administration of soluble salts of iron, while soil cultivation and the application of phosphatic manures tend to bring about the disappearance of this disease. As a result of the knowledge thus brought to light by scientific and experimental research, lands which formerly proved ruinous to farm, or simply remained derelict, are now profitably occupied.

" Brittle-bone disease " (osseous cachexia) is not infrequent among sheep depastured upon soils in the North Island, which are notably deficient in lime. Although somewhat rare in New Zealand, droughty conditions influencing the character of the herbage favour the appearance of this complaint, which may be attended by serious economic loss through spontaneous fracture of bones, unthriftiness, and poorness of the fleece.

When we come to consider diseases of an infective nature, it is obvious that New Zealand sheep farmers are at a great advantage compared with those of other countries. Such devastating complaints as anthrax, foot-and-mouth disease, and specific lamb dysentery, are non-existent, while blackquarter, although attacking young bovines, does not appear to affect sheep in New Zealand. Septicæmic conditions, due as a rule to invasion of the tissues by the organism of malignant œdema, occur on farms where sanitary precautions are neglected, under these circumstances being especially prevalent during lambing, and the subsequent operations of docking and castration. Heavy losses have been known to follow, but these are avoidable by respect to cleanliness and the use of clean yards or fields.

" Black disease " of Australia, which in many respects resembles European " bradsot " or " braxy," affects in certain seasons hoggets fed upon growing root crops. Observations in New Zealand support the findings of Dodd in New South Wales regarding the pathology of this braxy-like condition, and indicate that liver fluke may serve to introduce the causal organism. Acute stomatitis and facial eczema of lambs and sheep is a seasonal complaint met with generally in the late spring and summer, particularly during dry weather. A scaly eruption appearing on the mouth parts of lambs is conveyed to the udders of the ewes, producing a papular eruption which later becomes covered with dark-brown scabs. The sides of the face and ears share in the infection, and give affected animals the appearance of being plastered with mud in these regions. This disease has been attributed to infection with a staphylococcus, and in fact the symptoms may be reproduced by experimental inoculation with cultures of the organism isolated from pre-existent cases. Recent work on this subject, however, seems to point to a filtrable virus as the responsible initiating agent,

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other organisms being regarded as merely secondary invaders. This trouble is readily amenable to treatment, especially if fresh pasture or change of green food be available. Local treatment by the application of 5 per cent. solution of creolin in water relieves the irritation and destroys the infective virus, whatever this may be.

Amongst the disabilities of the parturient period, prolapse of the vagina is certainly one of the most troublesome. This accident may follow parturition, but it may also occur prior to the act. To farmers, this condition is known as having the " bearings down." It consists of an extrusion of the vagina, exposing an acutely congested and sometimes necrotic mucous surface. Prolapse of the uterus occasionally follows, although this sequel is fortunately by no means the rule. Treatment of individual ewes by returning the prolapsed parts after cleansing and disinfection, the administration of a sedative dose of opium, and also a laxative dose of castor oil to overcome straining, is frequently effective. In some cases it may be necessary to adjust a vaginal clamp or insert two or three sutures across the vulva to prevent a recurrence of the prolapse. When numbers of ewes are affected, individual treatment is tedious, or even impracticable. The exact cause of this tendency to prolapse has not been definitely determined. Here, again, some deficiency or defect in mineral metabolism may be responsible, for the complaint seems often to affect the breeding ewes on certain stations and in certain localities, while under precisely similar conditions of shepherding sheep elsewhere escape.

Accompanying the foregoing condition, and sometimes independent of it, ewes may suffer from a form of paralysis called, on account of its seasonal appearance, " ante-partum paralysis." Nearly always fat ewes and those carrying twin lambs are attacked. Autopsies reveal an excessive amount of internal fat, and the liver is found, on microscopical examination, to be the seat of a fatty infiltration. In the early stages of this form of paralysis calomel, followed by saline laxatives, have been found to yield good results. The preventive measures advocated include restriction of diet, change of pasture, with a run off on rape or green oats, and exercise. The latter point is important in regard to ewes heavy in lamb ; the ewes are naturally disinclined to move about freely, especially in the presence of abundant food supplies. A judicious amount of forced exercise certainly seems beneficial in preventing paralysis, as well as other parturient troubles to which the breeding flock are liable. Ante-partum paralysis appears to be very widespread throughout the flocks of New Zealand. Last year's report of the Department of Agriculture states that " this trouble was in evidence in almost every sheep-farming district throughout the Dominion."

Acute renal congestion is a condition which gives rise in some seasons to heavy mortality among lambs up to about two months old. It affects lambs in some districts more than in others, and is principally confined to Otago and South Canterbury in the South Island. On post-mortem examination the kidneys are found to have undergone degenerative changes which have reduced their con-

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sistency to that of pulp, held together by the investing capsule. This condition has been assumed to be due to plethora following upon a too rich food supply in the shape of the ewe's milk with, in addition, the grass feed which at this period the lamb is beginning to consume. This theory is supported by the fact that docking and castration, which implies a certain amount of blood letting, and consequently relief to the congested organs, are usually followed by a cessation of the mortality. Yarding the ewes for twenty-four hours, which temporarily reduces the milk yield by 50 per cent., has also been found of value in checking the losses among the lambs. The actual cause of this complaint is not, however, at present understood. Recent work on the subject seems to point to a specific toxin formed in the bowels as being responsible. It has in fact been found possible to reproduce the condition, or one indistinguishable from it, by the inoculation of toxins derived from the bowel into lambs experimentally.

Arthritis in lambs is a somewhat prevalent condition in some districts. It assumes the form of a polyarthritis involving chiefly the joints of the knee and hock. Affected lambs are more or less incapacitated, and suffer in consequence considerable loss of condition. It has been assumed that the infection of the joints proceeds by way of the unclosed navel, although in many cases there does not appear to be any clinical evidence to support this view. Treatment by segregating and hand feeding the affected lambs, and the application of iodine ointment to the enlarged joints, is generally followed by a partial or complete return to normal activity. The joint frequently remains enlarged, and in adult sheep pus may be found in the region of an infected joint encapsuled and shut off from the blood stream by the formation of fibrous tissue. The condition is of economic importance as tending to retard the young animals' development. Lambs which have once been affected with arthritis can seldom be marketed as prime.

Lymphadenitis.—This insidious complaint is met with in various parts of New Zealand, but more generally in Canterbury and North Otago. It is due to the entrance into the body tissues of a specific organism—the Preisz Nocard bacillus—which locates itself principally in the lymphatic glands, but which, however, may produce abscess formation in any part of the body. The characteristic pale-green pus indicates the nature of the infection. On account of the absence of any noticeable symptoms during life, and the deeply-seated lesions rendering their presence at times exceedingly difficult and sometimes impossible to detect by ordinary routine methods, the disease proves most troublesome from the point of view of meat inspection. The study of lymphadenitis has not yet disclosed the portal of entry of the infective organism. It has been held that the Preisz Nocard bacillus is capable of leading a saprophytic existence outside the animal body, and that young animals during the period of dental eruption may absorb the organism while grazing. In like manner, older animals with broken mouths may become infected through the exposed alveoli. Infection of wounds during shearing operations or castration may also be assumed to provide

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access to the specific organism. The slowly forming abscess having been adequately encapsuled with fibrous tissue, lymphadenitis, even in advanced cases, is not followed by mortality. Thorough post-mortem examination can alone determine its presence, but such procedure, entailing incision of lymphatic glands situated in the musculature, may ruin the appearance of the carcase. The knowledge that this disease cannot be communicated to the human subject is poor comfort to offer to the consuming public. It is disconcerting to discover a portion of purulent gland on one's dinner plate. Every effort must be made, if only upon æsthetic grounds, to combat in every country where it exists this troublesome complaint. The great meat exporting countries are fully alive to the importance of this question.

As regards parasitic infestations, New Zealand offers very little difference from what obtains among sheep of other countries of similar temperate climate, with the notable exception that sheep scab (psoroptic mange) does not exist. Verminous gastro-enteritis takes its annual toll of lambs in the autumn and winter months, especially following upon a wet season. Nothing has proved more effective in combating this formidable complaint than a supplementary ration of oats, lucerne hay, and other dry, nutritious feeds. These measures must, indeed, take precedence over any medicinal treatment, the results of which are uncertain, while the mass dosage of lambs consumes much valuable time, and is not unattended by risks. Lousiness is largely responsible for backward condition and resultant damage to the fleece. Most farmers are aware of the importance of dipping as a means of keeping sheep free from vermin of this nature. Maggot-fly infestations are very troublesome, and the resulting losses and suffering among flocks may be serious. The natural enemy of the blow fly—*Alysia manducator*—has recently been introduced into New Zealand, and it is anticipated that by the assistance of this parasite the ravages of the blow fly may be checked.

It is hoped that this brief résumé of the position relating to some of the ailments afflicting sheep in New Zealand may be of interest to those who wish to be acquainted with the veterinary aspect of the country's most important industry. The Dominion of New Zealand, one of the first countries of the Empire to establish and maintain a State Veterinary Service, now has a veterinary personnel as well equipped as any in the world to investigate and control animal diseases. No other country offers to the farming community greater facilities to obtain technical advice and assistance upon every branch of the agricultural and pastoral industries. *The Journal of the New Zealand Department of Agriculture*, published monthly, usually contains informative articles regarding the progress which is being made by officers of the department in their pursuit of knowledge calculated to benefit the farmer. The Annual Reports of the Department also repay perusal by all who are interested in the development of the youngest, though probably the most progressive, country in the British Empire.

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A CONCISE ACCOUNT OF THE IMPORTANT DISEASES MET WITH AMONG EGYPTIAN SHEEP.

By ZAKI MORCOS, M.V.Sc., F.R.C.V.S., D.V.H.
Professor of Bacteriology, Cairo School of Veterinary Medicine.

(1) Foot-and-Mouth Necrosis in Sheep.

SYMPTOMS and lesions were noticed confined to the oral cavity and foot of the affected animal in the form of grey-greenish looking ulcers of a characteristic odour—that of a decayed tooth. The ulcers were produced by an anaerobic gram and slender, long, necrosis bacillus, and the lesions were produced on intra-dermal inoculation into guinea-pigs at the seat of inoculation (but no secondary lesions were seen in guinea-pigs, and culture filtrates did not produce any lesions), thus distinguishing this disease from foot-and-mouth disease. The disease was discovered by the author in 1928. Single and coalescent ulcers were seen on the tongue, gums and lips, with or without ulcers on the heel and between the cleft of the hoof, thus profuse salivation and inability in feeding, and when the feet were affected the animals were seen lying down and walking on the knees when moved. The disease was only seen among Egyptian sheep. Mode of infection *via* ingestion or wound inoculation.

Prevention.—(1) Change of the field used for grazing, and digging up of same. (2) Destruction of the heavily infected subjects. (3) Copper sulphate dip for feet, and smearing of the oral cavity with treacle and alum, or glycerine and iodine.

(2) Sheep-Pox.

The disease occurs frequently among native and Sudanese sheep, and mortality varies. In some outbreaks the mortality may not exceed 2 to 5 per cent., while in others 25 to 35 per cent. were recorded. Between 1913 and 1924, about 6,500 cases were reported. The disease spreads very rapidly. While I was at the Luxor quarantine on the inspection of a sheep train arriving from Shellal—a few hours' journey—twenty to fifty cases among 2,000 sheep were detected, although the animals were inspected before leaving Shellal. Pox lesions make their appearance under the tail, on the face, axillæ, and, when advanced, may be seen almost anywhere on the body, especially along the abdominal wall.

Vaccination.—(1) Scarification of healthy sheep with the blister contents of an infected one. Very successful; but about 5 per cent. may be severely infected, while the majority react and possess resistance. (2) Blister contents attenuated, I believe, with certain dyes; fairly successful. (3) That the passage of sheep virus into goats, and the vaccination of sheep with the goat virus will soon be tried in Egypt.

(3) Coccidiosis in Egyptian Sheep.

Most outbreaks are due to *Eimeria faurei*, and the disease takes either an acute or sub-acute form; the former is accompanied by heavy losses; up to 10 per cent. of the affected may succumb, and at times much heavier losses are encountered. The main lesions are gastro-enteritis. Both native and Sudanese

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sheep suffer from the disease. The disease was first detected in Egypt by Dr. Asker Bey, and confirmed by Major F. E. Mason.

(4) Septicæmia Hæmorrhagica in Sheep.

Heavy losses occur in pasteurella infection, but contacts are treated with immune serum prepared from immunised cattle or horses, and vaccines prepared from cultures treated by heat or chemicals are also successfully used when required. The disease was first seen in Egypt by Dr. Guindi, and diagnosis confirmed and reproduced in laboratory animals and sheep by Major F. E. Mason (1915).

(5) Ovine Caseous Lymphadenitis.

The disease was first reported in Egypt by Major Rabagliati among Egyptian goats, later Preisz-Nocard bacillus was isolated from Egyptian-bred sheep by Major F. E. Mason (1913). No cases reported among Sudanese sheep, but very few cases detected annually in Egypt among sheep on meat inspection in abattoirs. Besides enlarged and suppurating lymph glands, abscesses were seen in the lungs of the affected.

(6) Piroplasmosis in Egyptian Sheep and Theileriasis in Sudanese Sheep.

Babesia ovis, although rare, is seen, and *Theileriasis* was first clinically spotted by Dr. Asker Bey, and confirmed microscopically by Major F. E. Mason (1919). With both infections mucous membranes become pale, appetite diminished; and when infection is heavy and the animal about to die, appetite lost, dullness, and rise of temperature; microscopic confirmation is inevitable, and reproduction of the disease in healthy lambs by tissue inoculation (spleen) may be essential in Theileriasis. Post-mortem: Yellowish-looking lining of body cavities and tissues; œdema of lymph glands, and enlargement of the spleen.

Arrhenal, subcutaneously, improves cases suffering from small intra-erythrocyte parasites, and trypan blue for the large protozoa (babesia).

(7) Sarcosporidiosis.

Although very rare in sheep, it was reported by Major F. E. Mason. When the infection is heavy, the animals die suddenly in a manner not unlike anthrax, but the sarcocysts will be seen in the muscular tissues, and quite possibly the spores will be detected in the blood. Before death, inflammatory œdema of larynx, fauces and base of tongue will be noticed.

THE USE OF ELECTRICITY FOR SLAUGHTERING SHEEP PAINLESSLY.

By D. J. ANTHONY, M.R.C.V.S., D.V.S.M.
Chief Veterinary Officer, Messrs. Marsh & Baxter, Ltd., Brierley Hill.

For some years electricity has been used in order to render pigs unconscious before slaughter, most of the work in this connection having been done in Germany and America. The method at present in use is the one invented by Professor

Muller, of the Veterinary College at Munich, and Herr Anton Weinberger, an engineer, also of Munich. In Great Britain, the General Radiological and Surgical Apparatus Company, of Great Portland Street, London, have brought out an instrument known as the S.R.V. Electrolethaler No. 2, being the latest improvement on the Muller-Weinberger method. This electrolethaler has been installed in various centres throughout the British Isles, and has proved quite a success as a " humane killer " for pigs.

Hitherto there has been some hesitation to adapt this instrument for the stunning of sheep and calves, owing to the wool acting as a non-conductor of electricity. The Electrolethaler No. 2 is in the form of a large tongs, the handles being well insulated, and connected by cables to a transformer, which converts an ordinary current of about 200 volts down to about 40 to 70 volts. A button switch is fixed into the right handle of the instrument in a convenient place for the operator's thumb to rest upon it. The electrodes at the ends of the tongs have spongy pads fixed between some metal spikes about an inch long, and these pads are dipped in 20 per cent. saline solution before each application of the electric current to the animal. The instrument used at Messrs. Marsh & Baxter's factory at Brierley Hill has the metal spikes about one-quarter inch longer than those fitted to the standard type of Electrolethaler No. 2, this being done so that it would give better " contact " with large sows, etc. The instrument is well insulated, and free from danger to the operator, provided reasonable care is used.

Having successfully used it upon some thousands of pigs, it was decided to try and adapt it for sheep. An extra plug was fitted to the transformer, and was connected by cable to a wall-plug in the sheep slaughtering room. The first sheep to be stunned were selected with a good woolly covering over the head and nose, so that we could ascertain once and for all time whether this instrument was as ineffective for sheep as had been reported to us. To our surprise the animals were stunned instantaneously as for pigs, without the slightest trouble. The current was applied for about twenty to thirty seconds for the first twenty sheep, but this was subsequently found to cause extensive " blood splashing " of the carcases and offal, so that the current application had to be reduced to a maximum of fifteen seconds, as for pigs. Since then we have found that from five to ten seconds application of the electric current is ample to render sheep unconscious. By this means we have successfully stunned about 2,000 sheep to date, the animals being of various breeds, including Southdowns, Shropshire, Border Leicesters, Hampshire Downs, Welsh Mountain, Kerry Hill, together with various crosses, some with " clean " faces, others with the wool coming well over the head, leaving only the tip of the nose " clean."

When the sheep is laid on the " cradle," and the current is applied, the electrodes being placed on either side of the head, over the ears, the animal closes its eyes, there is a convulsive movement throughout the musculature, the two fore-legs are extended and rigid, whilst the hind legs are flexed, being drawn up under the body. This is followed by a violent kicking movement in the hind legs.

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When the current is switched off the eyes open, the corneal reflex being absent in most cases, the pupil insensitive to light. There is a general relaxation of the muscles and limbs, the heart beat averages about 120 per minute. Whilst the current is on, the bladder and rectum are often emptied in sheep, more so than in pigs. The animal remains insensitive to everything around it, and thus can be bled effectively without causing any pain. In the old method of sheep slaughtering it was the custom to first lay the animal on its side on a " cradle," thrust a sharp pointed knife into its neck just behind the angle of the lower jaw, the knife passing through, and out the other side of the neck, a twist being given to it whilst it was still in the wound, to allow the blood to drain freely. The knife was then withdrawn, and the sheep's head violently wrenched upwards to " break its neck." It was then allowed to slowly drain the blood away and die. A similar procedure was adopted for lambs, and that is the usual method in use in most slaughter-houses throughout the country to-day. Although there has been considerable controversy regarding methods of slaughtering animals, I think few reasonable people will care to defend this old-fashioned method of sheep slaughtering. The Electrolethaler No. 2 does away with the dangers inherent in the use of a bullet-firing instrument, whilst the effect on the meat is all to the benefit of the butcher and consumer, in that there is no splashing, provided the current is not applied over too long a period, as has been pointed out already. Not only is the carcase and offal unsplashed, but it bleeds better, and from tests carried out on pig flesh here and in Sheffield (the latter being reported upon in the *Veterinary Record* by Drs. Eddington and Elliott, Vol. XI, p. 1,303, 1931), it has been proved that the meat from an electrocuted animal contains less blood-colouring matter than that from an animal " stuck " without any preliminary stunning. As the animal does not struggle when being bled, the blood is not splashed about the place, it can be collected easier, and the volume so collected is greater than in the case of " stuck " animals. This is by no means an unimportant item, as blood forms a valuable by-product in all modern packing houses and abattoirs.

Thus it is apparent that the latest electrical device for the stunning of animals before slaughter can easily be used on sheep. It is undoubtedly a vast improvement on all other " humane killers," being less dangerous, more economical to use, instantaneous in action, rendering the animal quite insensible; and, what is more important, if desired, the animal can be allowed to return to consciousness. This happens a few minutes after the current is switched off. It is the aim of the inventors of this instrument to render the animals unconscious for a sufficient time to enable them to be bled to death without feeling any pain. In its present stage of development it is hardly possible to recommend its use for the performance of minor operations, in view of the fact that in the case of pigs, fracture of the vertebræ and even of the scapula may sometimes occur. Such cases depend a good deal upon the method of application of the current and time taken; and can be prevented in most cases by a single current application over a very short period, such as five seconds.

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It is to be hoped that this Electrolethaler No. 2 will be adopted for the stunning of sheep in all abattoirs throughout the country; as, provided the tongs are pressed close on to the head, non-conductivity of the wool is hardly noticeable. Tests carried out here indicate that the meat is in no way different from ordinary mutton as far as taste and quality go, whilst the carcase is certainly better bled, and the animal ensured of a painless death.

SOME OBSERVATIONS ON "SHEEP-SICK" LAND.*

By WM. C. MILLER, M.R.C.V.S., F.R.S.E.
Animal Breeding Research Department, University of Edinburgh.

FOR some considerable time past the agricultural position in Great Britain has been such that grassland farming utilised for sheep rearing or feeding, or for one or other phase of cattle production, has been more economically satisfactory than arable farming, and the observations which follow are offered with particular reference to permanent grassland sheep farming. The importance of grass for sheep is immense. Roughly speaking, some three-fourths of the total sheep in Great Britain are grassland and hill sheep, and it would probably not be incorrect to state that with the possible exception of early fat lambs sold for slaughter at the age of 3½ to 6 months, all sheep normally spend about half their existence on grassland, permanent or temporary. Much has been said and written recently concerning the extension of grassland and the shrinkage of arable land acreages, and there is little doubt that land is, in many parts, expected to grow grass pasturage which is not in the least suited for it. The reasons for this are beyond the scope of the present article, involving as they do a consideration of the geological and geographical environment of each pasture in question.

Much of this grassland has been sown out with a mixture of grass seeds, the proportions of which have been carefully adjusted by experts in agronomy, with a view to the constitution of a balanced herbage population, which, were the balance to be maintained, would no doubt be ideal. Natural population balances are, however, notoriously delicate, and very liable to become disturbed, and this applies no less to pasture flora than it does to wild fauna. The varieties are many. Primarily, there is risk of irregular germination, especially important where the land is more suitable for some varieties of herbage plants than for others, or where adverse climatic conditions follow sowing. However, in most cases, the first season's growth of grass represents the seeding fairly accurately. Subsequently, competition between different plants, and between them and weeds in the pasture, begins, and unless the grazings are judiciously managed, deterioration commences. The rate of deterioration is hastened by bad methods of husbandry throughout the whole year, and although somewhat outside the scope of the present article, they may be briefly reviewed here.

* Embodying a lecture given to the Glasgow University Agricultural Discussion Society, November, 1931. Published by request.

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Farming practices must of necessity vary enormously in different parts of the country, but under average conditions it is probable that the growth from a permanent pasture during the first spring and summer will be made into hay. The aftermath (foggage) will probably be grazed by sheep, and/or cattle. During the first season there is normally not much opportunity for disappointment, either with the pasture or with the stock grazed upon it. It is well known that sheep particularly, and perhaps ewe lambs especially, do remarkably well on first year foggage, whether permanent or temporary. During the autumn and winter the pregnant ewe flock may very probably be kept upon the pasture either with or without changes to other fields. Artificial feeding of concentrates may be practised, and since very many (perhaps most) ewe rations have too high an N-ratio, the bacterial output per sheep is raised. Since each year one of the biggest problems facing the sheep farmer is the provision of a " fresh, early bite " for the ewes as they lamb in spring, and since the acreage of temporary " seeds " hay has not recently kept pace with the expansion of permanent grassland for sheep, the newly laid down permanent pasture is usually given a rest from February or early March onwards, to be ready for the ewes and lambs as they are drafted out from fold or lambing pen. During this recuperative period a harrowing may be given to spread the dung and open up the soil. Incidentally, this may readily allow late frosts to penetrate more deeply than otherwise, may disturb and destroy the young roots of plants just commencing their season's growth, and if the ground is wet at the time, will undoubtedly pull out a number of valuable plants.

When the hungry lactating ewes are put out in the spring, there may be some three to five inches growth of grass, and it is not long before the freshly-sprouted and earlier tender nutritious blades are eaten. When the supply of these is done, the sheep must perforce eat the coarser and later-growing blades, unless the rate of stocking is low, when the early grasses will continue to be eaten. By the time the early lambs are three to four weeks' old, they will be nibbling grass themselves, choosing for preference the earlier and sweeter varieties. It sometimes happens that ewes and lambs are allowed to eat a pasture very bare during the period of early growth, and do irreparable harm to it. With judicious management, however, by the time there are most mouths to feed, the peak period of growth (in May or June) is reached, and a balance is established.

With under-stocking during the flush period there is opportunity for the sheep to indulge in selective grazing, the grasses which appeal most to the palate are most eaten, while the less enticing, and therefore most probably the less beneficial grasses, are neglected. Consequently, the latter, which are usually later maturing, are allowed to grow strongly and vigorously with such virility that they not only encroach upon the soil area which should accommodate the earlier grasses, weaker because they have been heavily grazed, but they are able to throw up flowering heads which in time seed, and each scatters its seed around the area to increase the competition with the finer grasses during subsequent

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seasons. The woody lignified stems are left sticking up as monuments to the killed-out earlier grasses. During the period when flowering and seeding of the later grasses is taking place, the earlier wether lambs are in all probability being drafted out fat to the butcher, and at the time when a heavier stocking would prevent flowering, the number of mouths is actually being reduced. A sound policy during this time of the year is, of course, to graze the rough top growth down with cattle, but there are those who can never secure enough cattle to cover all their sheep grasslands, and others who object to running cattle and sheep on the same pastures.

The autumn appearance of such pastures as have had nothing done to them to restrict the coarse growth is as follows: irregular tufts of rank woody blades of grass surround each flowered stem, while in between them the grass is cropped short and evenly. The uneaten stems on the outside die and fall down on to the soil surface, where they decompose—soluble constituents being washed into the soil.

As year succeeds year under such a type of management, the grazing qualities of the pasture deteriorate, and the constitution of the grass population changes. The earlier grasses have been mostly killed or eaten out. There is a thick mat of decomposing acid vegetable matter on the surface of the soil which excludes heat, chokes out delicate plant growth, and retards drying of the growing plant stems, and it is noticed that sheep and lambs on such a pasture do not "do" so well as they did earlier. They are less inclined to settle than formerly, take from ten to twenty paces between each few mouthfuls (always a bad sign, the ideal sheep pasture encourages each sheep to graze straight along a line with a pause for grazing after each step the sheep takes). If cake and corn are being fed, the sheep spend an undue amount of time at the troughs, waiting for the shepherd in the morning, and are loth to leave them when the food is finished. So long as there appears to be a "good rough bite" on the pasture, the farmer may imagine all is well, and will probably keep his sheep on it even though they do not appear to be thriving so well. He has to feed a rather heavier trough mixture if he wishes to keep the ewes in good condition, which means added expense. When the weather is wet the ground around the troughs becomes churned up, and incorporated with it is a considerable amount of dung. Later in the year perhaps, or during a subsequent season, this ground grows a richer darker-coloured type of herbage than elsewhere, which is appreciated by the sheep.

Now after perhaps three or four years of management of this kind an odd ewe will die, a few cases of mammitis will occur, and in a number of cases lambs, for no apparent reason, will cease to thrive. Some of the newly-born lambs will be lost during the first eight to ten days of life, showing probably no very well-marked symptoms, except possibly diarrhœa. The ground has in effect become "sheep sick." This is admittedly a vague term, and one which is capable of being defined in different ways in different districts. It will be desirable here to indicate those conditions which may typically be considered to constitute

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sheep-sick pasturage, avoiding finer shades in meaning which are purely local or geographic.

In the first place, ground which is heavily over-stocked normally becomes sheep sick. It is well to appreciate that what consitutes over-stocking on one type of ground does not necessarily mean the same thing on another type. By taking extreme examples for illustration, one might say that on a hill farm in the north capable of carrying one sheep to every three and a-half or more acres, the results of doubling the stock might not be apparent for some two to three years ; but on a lowland grass farm carrying, say, five sheep per acre, the effect of doubling the stock would probably be apparent in eight to twelve weeks or less. In the case of hill pasturage, the result would be demonstrated by decreased milk yield in the ewes, giving a slower rate of growth of young lambs and a deterioration in the quality of these at weaning time. The actual death-rate, unless in a severe winter storm, would not be materially heavier than usual, though the so-called " black loss " might be greater. On the lowland grass farm the result would be shown by failure to thrive and loss of condition, not because of the insufficiency of the grass, but because of the soiling of a large amount of herbage by dung and urine, and the refusal of the sheep to eat it in consequence.

The habits of feeding of sheep are of immense importance. On the whole the sheep is a discriminating and particular feeder, and in proportion as the habit of life of the sheep approximates the wild state so does this particularity increase. The mountain-bred ewe will, at first at any rate, almost starve herself, or will break out through fences, rather than feed on badly fouled land, while the Down breeds, folded on turnips, are much less discriminating in their choice. There is another difference : the mountain sheep is an individualist in feeding, separating itself from its neighbours, foraging for itself, and requiring plenty of room to do so, while lowland sheep are gregarious in the strictest sense of the word. Possibly the merino is the least discriminating of modern breeds, and exhibits the gregarious instinct in the highest degree, while the Scottish mountain blackface occupies the other end of the range.

The second cause of trouble is the spread of bacterial infection on the pasture, and the consequent increase in the number of organisms taken in with the food. There are few recorded relevant facts upon which to base conclusions, since the subject has not to my knowledge been studied in detail. The bacterial flora of the ovine intestine is, of course, normally very considerable. Sheep pass out millions of organisms per day. The majority of these are non-pathogenic, but some are not so. Some pathogenic varieties are facultative in that while they can live externally in nature, they prefer to abide in the animal's body. These do no harm so long as the normal defensive mechanism of the sheep is unimpaired, but during concurrent illness from other causes, or when the number present exceeds normality, sheep may readily succumb to their attack.

On a pasture where the amount of excreta is high through over-stocking, during hot, dry weather, no serious trouble may be encountered, but during a

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heavy fall of rain the dung becomes disintegrated, and the bacilli are splashed around onto the growing herbage, to be eaten by the sheep later. A gentle rain, however, will tend to wash the grass clean and sweet, and encourage the sheep to eat it afterwards. Naturally, although the grass may be washed dung-free, it will not necessarily be washed bacteria free, so that sheep eating it may still be taking into their intestines abnormally large numbers of organisms. In this connection it may be useful to mention some figures recently obtained here, which, while obviously tentative, may enable a better appreciation of fouling of the ground to be achieved.

In some experiments this summer we put deliberately 160 ewes and lambs on to one acre of clean eight-inch long mixed grass, and allowed them to graze for twenty-two hours. Four plots of ten square yards each were marked off in different parts by driving pegs into the ground. After the twenty-two hours we collected and weighed the dung from these plots. The amount was equivalent to $4\frac{1}{2}$ cwt. per acre for twenty-two hours grazing (or 4.6 cwt. per twenty-four hours). This, if spread evenly over the whole acre, would be equivalent to a layer of about 7/1000 of an inch of dung (*i.e.*, 175μ in thickness). Obviously, it does not often happen that so many sheep as 160 per acre are grazed on grass, although this concentration is often exceeded when sheep and lambs are folded on turnips or clover aftermath, etc., but the figures are useful for comparison, for example, fifty sheep grazed for three days would give approximately an equivalent soiling of the ground, and so on.

The third and possibly the major cause of trouble on over-stocked sheep-sick land, is the rise in the amount of infestation with parasitic worms. The number of sheep in this country which harbour no worms at all (apart from the purely mountain breeds) is very small indeed. Some authorities state that there are none; that all low-ground sheep carry at least a few worms in their intestines. However, in most flocks of any size there are worms present in some of the sheep, and the more there are, the more rapidly does severe trouble arise. The degree of infestation with worms which a sheep can withstand, and still remain clinically healthy, has, so far as I know, not been determined. In all probability it would vary with individual animals and with different species of worms, but it seems rational to suppose that below some standard level of infestation a quite harmless symbiosis can exist between host and parasite to the detriment of neither. When for any reason infestation passes beyond this safe level, clinical symptoms are exhibited by the sheep, and a vicious circle commences; the weaker the sheep becomes the more rapidly the degree of infestation rises, and, conversely, the more rapid the infestation or re-infestation the weaker the sheep becomes, and the less is the natural resistance to bacterial invasion. It is well to remember that in the case of those worms which attack the gut wall, each tiny puncture provides a portal of entry for pathogenic organisms. A point to remember when considering over-stocking is that the more over-stocked the land is, the more is the herbage contaminated with dung organisms, and the greater are the numbers of

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these present in the intestines, so that relatively fewer worm punctures (in the case of blood-sucking worms) may be quite as serious as would a larger number of punctures where the bacillary concentration was less. This to some extent may explain why on post-mortem so very frequently only a disappointingly few adult parasites are found, although another reason often is that many of the dangerous microscopic forms are not visible to the naked eye.

In the experiments to which I referred, collections of fæces were examined, and samples of them were submitted to egg-count technique. Without going into details of numbers, we were amazed to discover that even from our own sheep, in which the numbers of worms were certainly not above normal, since clinical symptoms were absent, over one million eggs per day were being eliminated. This gives an average of some 6,000 eggs per day per sheep. Taking 3¼ lb. excretion of fæces per day, the number of eggs per gram of fæces was forty-five, which is quite a low number. Consequently, with only a light average infestation with worms, sheep when concentrated upon too small an area of ground act as a grave menace to themselves. The majority of adult female worms specific for the sheep apparently are able to produce about 1,000 eggs per day during their active reproductive life, so that as few as some six or eight female worms harboured in the intestines of each sheep are capable of contaminating a pasture to an excessive degree when overcrowding occurs.

It is perhaps necessary to remember that the modern tendency in agricultural practice is towards a greater intensification of production, and intensified grassland management is gaining in popularity. With cattle, an extension of this intensification does not appear to be fraught with the same risk that attends its utilisation for sheep, for the reason that the adult bovine alimentary canal appears more robustly constituted and more immune from parasitic invasion. So far as the sheep is concerned, therefore, it would appear that it is time man ceased to endeavour to make two blades of grass grow where one grew before, if, indeed, that is what he is doing. The intensification of grazing carries with it a risk of local calamity from over-stocking, even though by it the quality of the grazing and the economic returns from it may be improved.

Fully cognisant of the difficulties, it would seem to be desirable to suggest some means whereby such risks as these may be minimised. To the professional grazier who has made of grassland management an art as precise and perfect as has the specialist in any other branch of agriculture, the dangers are perhaps not great, but to the man who has neither the experience upon which to build, nor the knowledge to guide him, assistance in recognising these dangers may enable him to avoid disaster.

The sheep is popularly considered to be a *close* grazing animal ; careful observations lead one to dispute this belief ; the sheep is essentially a *short* grazing animal. It does not eat all varieties of herbage close down to the ground, but it does prefer to bite off the shorter blades of grass, or, when these have grown long, to eat the tip before consuming the lower part of shaft or blade. Only when selection is restricted

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will sheep nibble down to the sole of the pasture, and eat close to the soil surface where parasitic larvæ and young forms are to be found, and where those small slugs, which act as intermediate hosts, are found. Consequently, one of the first requirements is that the pastures shall never be allowed to grow long and rank, or, if they are already so, they should have cattle grazed over them first, or what is better, should have the reaping machine run over them to remove the rough top, and to encourage new fresh young blades to sprout from the crown of each grass plant. These the sheep will appreciate, and they will appreciate the value of the sheep. The reaping machine should be the busiest of farm implements during the weeks of the peak flush of grass, and right on until the flowering season is over. During all this time, under ideal conditions, sheep should be upon the pasture for not longer than two to three weeks at a time, and in between times an equivalent period of recuperation should be allowed. In this way the grass mower keeps in check the vigorous coarser grasses, yet the sheep are not given a chance to kill out the earlier and more nutritious varieties by continuous grazing. In many places it may be argued that the land is such that this is not possible, a change-pasture is not available. In such, however, the obvious course is to split the field in question by a temporary netting and post, or other fence, and to graze each half alternately. In some cases further subdivision into three or four portions may be necessary.

Next, though it may not always be possible, from the sheep's point of view, it is desirable that every second or third year the pasture should be hayed. There is an art in haying a grass pasture to conserve the grazing value. Roughly speaking, it consists in waiting until the earlier nutritious grasses have actually set their seeds, and are capable of spreading them on to the ground when cut by the mower. At the same time the hay must be cut before the coarser and later grasses have reached the same stage. Obviously a certain amount of potential feeding value of the hay is in this way sacrificed, but the feeding value of the pasture improves in proportion.

The subsequent management of the aftermath is no less important. The ground is clean, has carried no sheep for some months, and therefore dung bacilli and worm eggs or larvæ are certainly not numerous. In other words, the freshly grown young blades are rich and nutritious, and the pasture is safe. It is ideally suited for a run for the stock ewe lambs firstly, and for the ewe flock later. In the autumn there is every reason why such aftermaths should be heavily stocked. One of the secrets of success in grassland management is heavy back-end grazing, and another is thorough harrowing afterwards, and not later than December. Sharp-toothed harrows spread dung, tear out moss, etc., break the creeping stems of couch and knot grasses, pull out at least some of the Yorkshire fog, and open up the surface of the ground so that seeds, which have probably lain on the dry surface of the soil most of the summer, may get covered and germinate. In addition, the ground is opened to receive any autumn artificial manure top dressings that may be given, and it will have settled again before the heavy

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frosts begin. During winter, when trough feeding must be given, it is of great advantage to feed in one field, but graze the sheep in another. The troughs should without fail be moved to new ground every day, in such a way that in time the whole field, or nearly so, has been covered, and the stamping and dunging around the troughs has been distributed.

Allowing the sheep to the troughs for only an hour each day, and then putting them to another pasture, serves a double purpose with in-lamb ewes, in that it provides exercise, ensures regular circulation, and gives the necessary stimulus to the bowels. Such ewes are inclined to underdo rather than otherwise the amount of exercise they take voluntarily.

It is not easy to suggest methods whereby the concentration of potentially pathogenic organisms may be kept under control in pasture land. The avoidance of over-stocking, and the prevention of a dense felted mass of decomposing vegetable debris on the surface of the soil by proper management will help. Thorough aeration of the upper layers by harrowing or other cultivation will keep down the anaerobes, while draining will serve the same ends. Liming where necessary may help, but I am not aware of any specific method of controlling the potentially pathogenic bacterial flora of the soil. It may be that top dressings of artificial manures may in future be devised which will exert a sufficient amount of antiseptic action to control bacilli without harming the herbage.

I would suggest that so far as worms are concerned, the sheep-owner has a method of control at hand. It has been shown on numerous occasions that by repeated dosings with appropriate drugs of known potency and purity each month during winter, from October to March, the worm infestation in a flock of sheep can be kept within bounds ; and though the parasites are not eliminated altogether, and although re-infestation from the pasture is certain to occur, heavy losses from worms will not ordinarily arise, and there will be no check to growth or thrive in the younger animals.

The observations submitted are of necessity somewhat discursive, but so is the subject. It is possible that a recognition of the three-fold nature of the cause of " sheep-sick " pastures may enable more appropriate measures to be taken to avoid them, while some further degree of correlation between helmintho-logical and bacteriological investigations might well repay exploration.

Finally, this opportunity may be taken to emphasise once again the great desirability that he who aims to equip himself with the best weapons to fight animal disease should not neglect a knowledge of the problems of animal management.

The writer wishes to acknowledge the assistance rendered by Dr. T. W. M. Cameron, who undertook the estimations of worm-eggs in the samples of fæces to which reference has been made.

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LAMBS ALL THE YEAR ROUND.*

THE public preference for small joints is clearly indicated by the relative prices per lb. of heavy and light-weight mutton and lamb. From about Christmas, when the earliest lambs come on the market, till well after Easter, it is not uncommon for lambs, twelve or fourteen weeks old and weighing 70 to 75 lb. alive, to realise not only more per lb. than sheep of nine months or over, but actually as much, or even more, per head. There can be little doubt that early maturity, so far at any rate as lambs are concerned, normally pays well, for the fattening process is completed in about three months, during which period the lamb is nourished by its mother's milk.

A quick turnover is one of the most important factors in modern business enterprise. Just how far this can be intensified, in line with the public demand, is a question well worth the attention of sheep breeders. Here and there an enterprising farmer with a considerable range of land has succeeded in so arranging his business as to be able to supply milk-fed lambs in any week of the year. The basis of his system is a flock of Dorset Horn ewes, supplemented by one or other of the normally less fertile and later-lambing breeds to fill up any gaps left open by the Dorset Horn. Starting with Dorset ewes, purchasable at the annual fairs in May, lambs may be expected to arrive in October. Rams of early maturing Down breed run out with the flock all the year round, and " catch " the ewes as they again come in season, frequently about ten days after lambing. The first family will be ready for sale from about the New Year onwards, and the second in the course of the summer. Twice breeding per annum is not, of course, always or even generally mathematically exact as to time ; the third lambing will usually be somewhat later in the year than the first, but the effect of buying in annually a batch of young ewes which are kept on till they are broken-mouthed, is that lambs are born from one or other of the several ages of ewes practically at all times of the year. Supplies at Easter are supplemented by lambs from a Down breed, which are normally born in January.

It may be supposed that lamb-breeding on the lines indicated entails much arable cropping and folding. This, in fact, is not the case. One farm recently seen was mainly in grass. Much of the pasture was, indeed, of recent sowing, and able to provide both early and late keep, but it was only in the barest months of the year that folding, on kale, was practised. On sound, dry land in the southern counties, where the winter is seldom severe, lambing in autumn, or even in January, has many advantages over the more general lambing in March. Of all the months of the year, March is the one when keep is generally shortest and milk is most expensive to produce, when the winds are keenest, and the ewes, unless in very fit condition, are least able to withstand chills. Nothing will fatten a lamb so well as milk ; and nothing will produce milk so well as grass. In March there is usually neither grass nor other succulent green keep. Even kale, wizened,

* From the Ministry of Agriculture and Fisheries, March 18th, 1932.

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frost-bitten, and innutritious as it often is at this time of the year, will be neglected in favour of such scanty fare as a March pasture produces.

Successional lambing of the kind described is not everybody's business, but it appears to be a means, where the circumstances are suitable, of equalising and distributing supplies, and of making the lamb market more favourable for all concerned.

Obituary

PROFESSOR LABAT.

PROFESSOR LABAT, director of the Toulouse Veterinary School, recently died at the age of eighty-one. He held the positions of professor of surgery and therapeutics from 1876 to 1878, and was elected to the Chair of Pathology and Clinic in 1878, holding the office for twenty-seven years. In 1906, he was appointed a director of the school, and in 1924 an honorary professor. Professor Labat was a Licentiate of Natural Sciences, and a Doctor of Medicine. As a teacher he was beloved by his students, being a man of fine presence and peculiar charm. He was honoured by the Faculty of Medicine of Bordeaux, the Academy of Sciences, Toulouse, and the Council of Hygiene, and was the recipient of numerous prizes and medals. He did good work in research into epizootic diseases, and wrote many articles on medicine, surgery, and hygiene.

Personal

CONGRATULATIONS to Major A. C. Duncan, M.R.C.V.S., the popular lecturer in veterinary science at the Royal Agricultural College, Cirencester, on being the recipient of an Honorary Science Degree of B.Sc. in Agriculture conferred by the University of Bristol. Major Duncan is also a Barrister-at-Law.

AT the luncheon of judges and officials of the London Annual Parade of Van Horses, held in Regent's Park on Easter Monday, our colleague, Major-General Sir John Moore, expressed his regret that so much good English money went to the Irish sweepstakes fund, when it might be equally easily collected here and applied for the purpose of encouraging horse breeding, and such like industries in England. Incidentally, too, his opinion is shared by others who know the urgent necessity for obtaining funds for Veterinary Research, and if only such a course could be legitimately adopted, those who have undertaken the work of raising funds for the rebuilding and endowment of the Royal Veterinary College feel that their task would have long ago been considerably lightened.

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